jc685 U.S. PTO
08/03/00

JC490 U.S. PTO
09/632348
08/03/00

UTILITY PATENT APPLICATION TRANSMITTAL (Only for new nonprovisional applications under 37 CFR 1.53(b))		
Attorney Docket No.	195463US0
First Inventor or Application Identifier	Hiromitsu TANAKA, et al.
Title	ELECTRO LUMINESCENT ELEMENT

APPLICATION ELEMENTS
See MPEP chapter 600 concerning utility patent application contents

ADDRESS TO: Assistant Commissioner for Patents
Box Patent Application
Washington, DC 20231

1. ■ Fee Transmittal Form (e.g. PTO/SB/17)
(Submit an original and a duplicate for fee processing)
2. ■ Specification — Total Pages: 75
3. ■ Drawing(s) *(35 U.S.C. 113)* — Total Sheets: 1 (Formals)
4. ■ Oath or Declaration — Total Pages: 4
   a. ■ Newly executed (original)
   b. □ Copy from a prior application *(37 C.F.R. §1.63(d))*
   (for continuation/divisional with box 15 completed)
      i. □ DELETION OF INVENTOR(S)
      Signed statement attached deleting inventor(s) named in the prior application, see *37 C.F.R. §1.63(d)(2) and 1.33(b).*
5. □ Incorporation By Reference *(usable if box 4B is checked)*
The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4B, is considered to be part of the disclosure of the accompanying application and is hereby incorporated by reference therein.

ACCOMPANYING APPLICATION PARTS

6. □ Assignment Papers (cover sheet & document(s))
7. □ 37 C.F.R. §3.73(b) Statement *(when there is an assignee)* □ Power of Attorney
8. □ English Translation Document *(if applicable)*
9. ■ Information Disclosure Statement (IDS)/PTO-1449 ■ Copies of IDS Citations (6)
10. □ Preliminary Amendment
11. ■ White Advance Serial No. Postcard
12. □ Small Entity Statement(s) □ Statement filed in prior application. Status still proper and desired.
13. ■ Certified Copy of Priority Document(s) (1)
(if foreign priority is claimed)
14. ■ Other: Notice of Priority

15. If a CONTINUING APPLICATION, *check appropriate box, and supply the requisite information below:*
□ Continuation □ Divisional □ Continuation-in-part (CIP) of prior application no.:
Prior application information: Examiner: Group Art Unit:

16. Amend the specification by inserting before the first line the sentence:
□ This application is a □ Continuation □ Division □ Continuation-in-part (CIP)
of application Serial No. Filed on
□ This application claims priority of provisional application Serial No. Filed

17. CORRESPONDENCE ADDRESS

22850
(703) 413-3000
FACSIMILE: (703) 413-2220

Name:	Norman F. Oblon	Registration No.:	24,618
Signature:	MARVIN J. SPIVAK REGISTRATION NUMBER 24,913	Date:	8/3/00
Name:		Registration No.:	

Docket No. 195426US0

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

INVENTOR(S) Hiromitsu TANAKA, et al.

SERIAL NO: New Application

FILING DATE: Herewith

FOR: ELECTRO LUMINESCENT ELEMENT

FEE TRANSMITTAL

ASSISTANT COMMISSIONER FOR PATENTS
WASHINGTON, D.C. 20231

FOR	NUMBER FILED	NUMBER EXTRA	RATE	CALCULATIONS
TOTAL CLAIMS	13 - 20 =	0	× $18 =	$0.00
INDEPENDENT CLAIMS	2 - 3 =	0	× $78 =	$0.00
☐ MULTIPLE DEPENDENT CLAIMS (If applicable)			+ $260 =	$0.00
☐ LATE FILING OF DECLARATION			+ $130 =	$0.00
			BASIC FEE	$690.00
			TOTAL OF ABOVE CALCULATIONS	$690.00
☐ REDUCTION BY 50% FOR FILING BY SMALL ENTITY				$0.00
☐ FILING IN NON-ENGLISH LANGUAGE			+ $130 =	$0.00
☐ RECORDATION OF ASSIGNMENT			+ $40 =	$0.00
			TOTAL	$690.00

☐ Please charge Deposit Account No. 15-0030 in the amount of A duplicate copy of this sheet is enclosed.

■ A check in the amount of **$690.00** to cover the filing fee is enclosed.

■ The Commissioner is hereby authorized to charge any additional fees which may be required for the papers being filed herewith and for which no check is enclosed herewith, or credit any overpayment to Deposit Account No. 15-0030. A duplicate copy of this sheet is enclosed.

Respectfully Submitted,

OBLON, SPIVAK, McCLELLAND,
MAIER & NEUSTADT, P.C.

Date: 8/3/00

MARVIN J. SPIVAK
REGISTRATION NUMBER 24,913
Registration No. 24,618

22850
Tel. (703) 413-3000
Fax. (703) 413-2220
(OSMMN 11/98)

ELECTRO LUMINESCENT ELEMENT

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an electro luminescent element and in particular to improved organic compound materials for use in an electro luminescent element.

2. Description of the Related Art

An electro luminescent element is constructed by layering, in order, a transparent first electrode (such as, for example, an ITO), an organic compound layer with an organic compound having strong fluorescence, and a second electrode formed of a metal (such as, for example, Mg). The organic compound layer is constructed by layering a hole transporting molecule, a luminescence molecule, and an electron transporting molecule in order, and emits light when electric field is applied between the pair of electrodes. In other words, when holes are injected from the first electrode and electrons are injected from the second electrode, the injected holes and electrons move through the organic compound layer and collide with each other to recombine and vanish. By this recombination, energy is generated which is then used to produce an excited state of the luminescence molecule so that the element emits fluorescent light.

Such an electro luminescent element has advantageous

characteristics over other display elements such as a liquid crystal, a plasma display, or an inorganic electro luminescent element, such as no limitation on the angle of view, capability of being driven at a low voltage, and rapid response.

As a hole transporting material of the organic electro luminescent element, a TPD (tetraphenylbenzidin) which has been proposed by Tang et al. is widely in use. Because TPD has superior hole transporting ability, an organic electro luminescent element using TPD as a hole transporting molecule such as, for example, an element having a structure, [ITO / TPD (60 nm) / Alq3 (60 nm) / Mg:Ag (1500 nm)], has an excellent initial performance with a maximum luminance reaching few tens of thousand cd/m^2.

PBD (t-butylbiphenylylphenyloxadiazole) has been proposed as an electron transporting material by Tsutsui et al. PBD is a material having a high electron transporting ability and, at the same time, is a blue luminescence material of high luminance.

However, even though each of the conventional hole transporting, luminescence, and electron transporting molecules have good electric functionality characteristics, they also suffer problems of high crystallinity and low heat endurance. Because of these disadvantages, most of these materials cannot be used as materials for an organic electro luminescent element. For example, even though TPD (tetraphenylbenzidin) and triphenylamine are materials with good hole transporting ability, they exhibit high crystallinity and low heat endurance, which causes crystallization

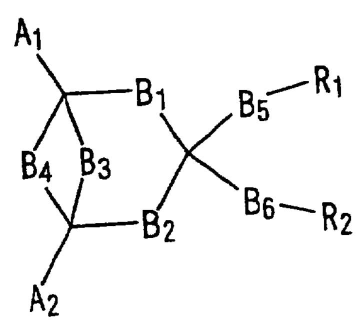
leading to element breakdown within one month after forming an element.

Similarly, even though PBD (t-butylbiphenylylphenyloxadiazole) is a material with good electron transporting ability, it has a fast crystallization, leading to an element breakdown within one week of forming a film.

SUMMARY OF THE INVENTION

The present invention is conceived to solve the above problems and an object of the present invention is to provide an electro luminescent element using functional molecules each having a function of hole transporting ability, luminescence, and electron transporting ability, the electro luminescent element having high heat endurance and low crystallinity.

According to one aspect of the present invention, in order to achieve the above object, there is provided an electro luminescent element comprising one or more organic compound layers between the electrodes, wherein at least one of the organic compound layers is a condensed ring compound derivative represented by a chemical formula,



in which A1 and A2 represent substituents, B1 through B6 represent directly combined or 2 functional substituents, and R1 and R2 represent functional units such as triphenylamine, coumarin, and oxadiazole derivative, etc., with each of the functions of hole transporting ability, luminescence, and electron transporting ability.

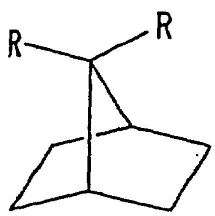
With the structure defined above, by using a condensed ring compound derivative for each of the functional molecules of hole transport, luminescence, and electron transport, low crystallinity and high heat endurance which are preferable characteristics of an organic electro luminescent element can be added while maintaining good electric characteristics. This is because the condensed ring compound has a non-planer structure and reduced symmetry of the molecule shape. Because of these factors, the crystallinity of the molecule is reduced and the movability of the molecule can be reduced by introducing a molecular skeleton of a rigid condensed ring compound, resulting in improved heat endurance.

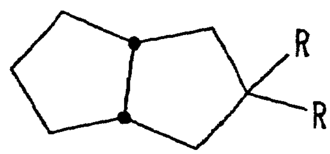
According to a second aspect of the present invention, there is provided an electro luminescent element with the structure of the first aspect, wherein each of the functional units R1 and R2 is selected from the group consisting of triphenylamine, coumarin, and oxadiazole derivative.

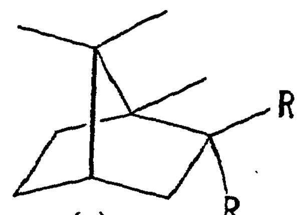
According to a third aspect of the present invention, there is provided an electro luminescent element with the structure of

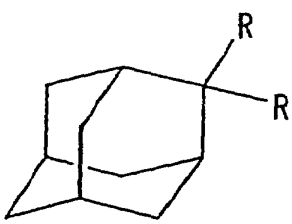
the first aspect, wherein the condensed ring compound derivative is distributed among host materials and the host material is further layered in the organic compound layer.

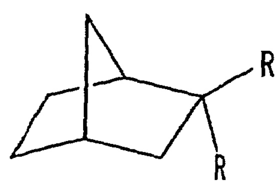
According to a fourth aspect of the present invention, there is provided an electro luminescent element with the structure of the first aspect, wherein the condensed ring compound derivative has a structure represented by one of the following chemical formulae (a) ~ (l):

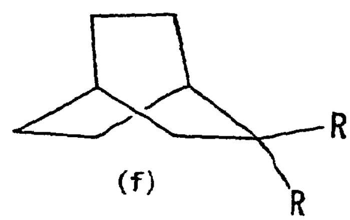

(a)

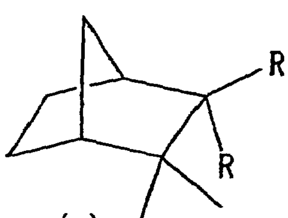

(b)

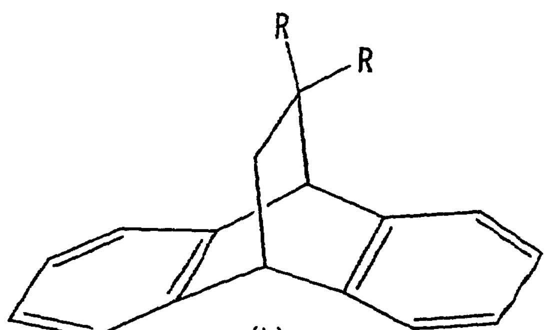

(c)

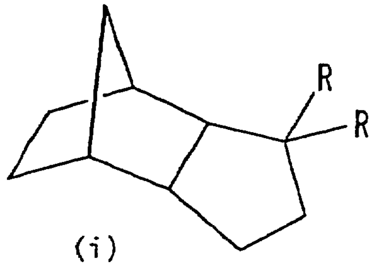

(d)


(e)

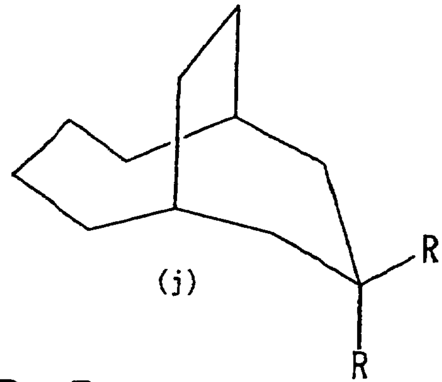

(f)


(g)

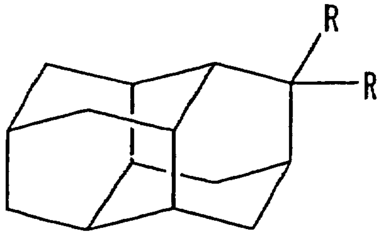

(h)



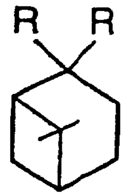
(i)



(j)



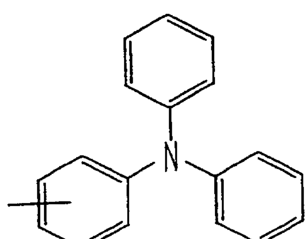
(k)



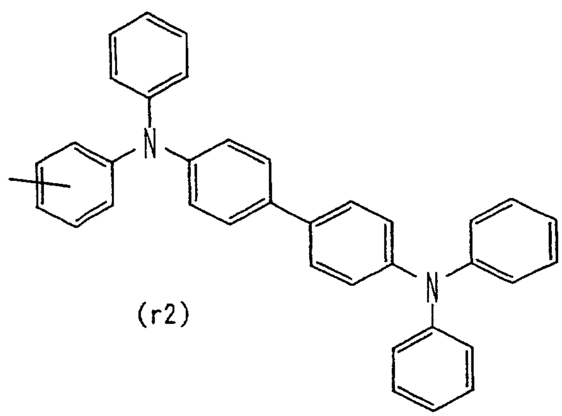
(l)

in which R represents the functional units.

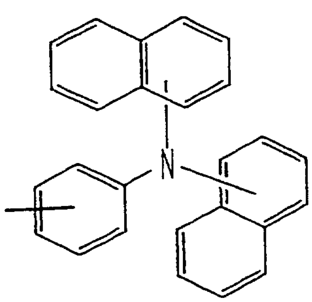
According to a fifth aspect of the present invention, there is provided an electro luminescent element with the structure of the first aspect, wherein the functional unit has a structure represented by one of the following chemical formulae (r1) ~ (r22):



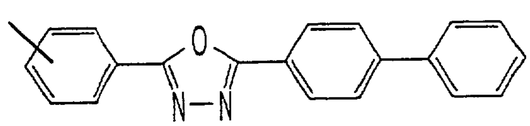
(r1)



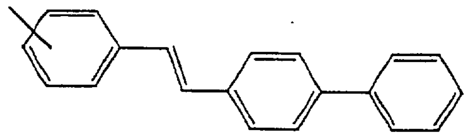
(r2)

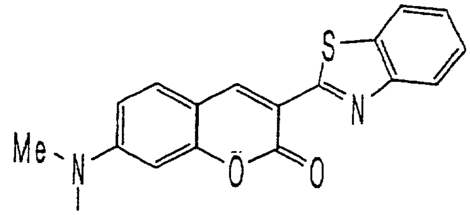


(r3)

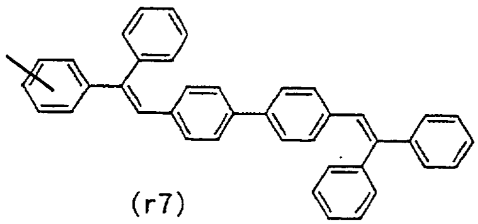


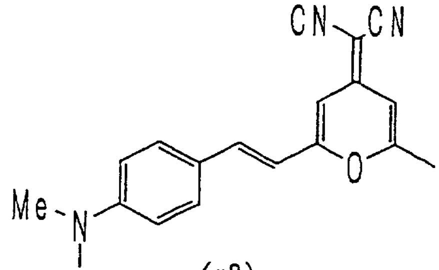
(r4)


(r5)

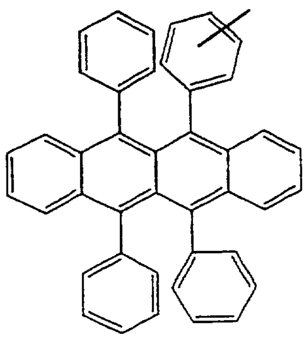


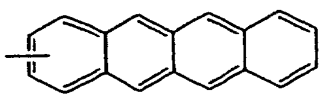
(r6)

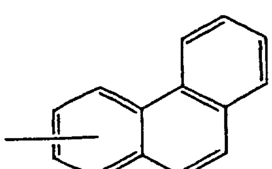

(r7)

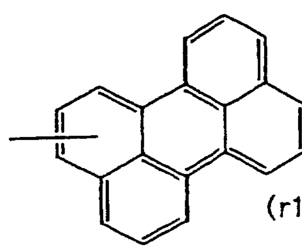


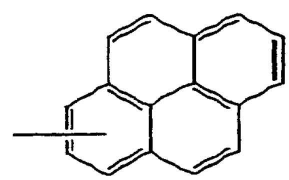
(r8)

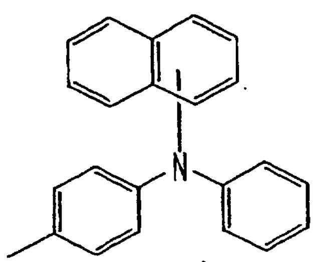

(r9)


(r10)

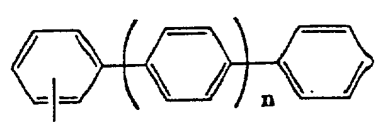

(r11)


(r12)

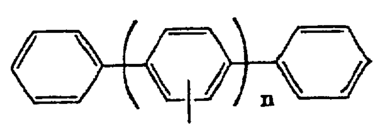

(r13)



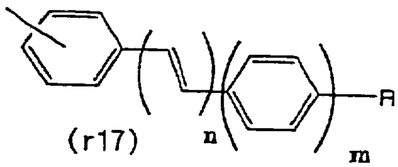
(r14)

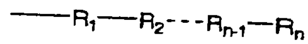


(r15)

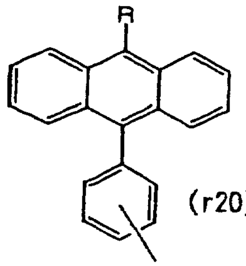


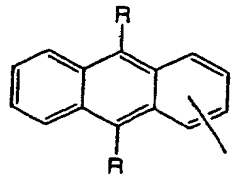
(r16)

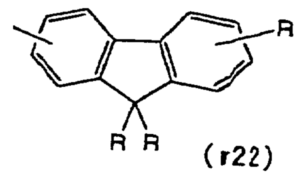

(r17)


(r18)


(r19)


(r20)

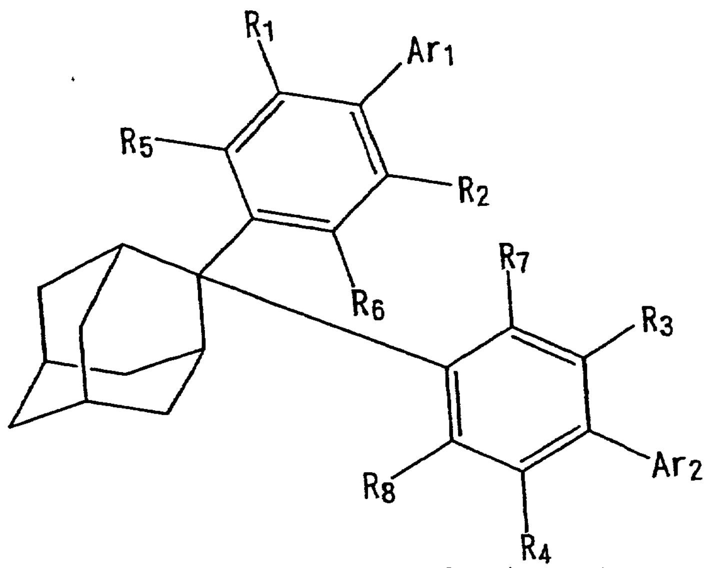

(r21)


(r22)

in which n, m, and i represent integers, R represents saturated hydrocarbon from C1 through C30, an isomer thereof, or an aromatic compound.

According to a sixth aspect of the present invention, there is provided an electro luminescent element with the structure of the fifth aspect, wherein the aromatic compound R is selected from the group consisting of phenyl, naphthyl, indenyl, fluorenyl, phenanthryl, anthranyl, pyrenyl, chrysenyl, naphthacenyl, benzophenanthrenyl, furanyl, thiophenyl, pyrrolyl, oxazolyl, isoxazolyl, pyrazolyl, triazolyl, furazalyl, pyridyl, oxazyl, morpholyl, thiazyl, pyridazyl, pyrimidyl, pyrazyl, triazyl, benzofuryl, isobenzofuryl, benzothiophenyl, indolyl, isoindolyl, benzoxazolyl, benzothiazolyl, benzoimidazolyl, chromelyl, quinolyl, isoquinolyl, cinnolyl, phthalazyl, quinazolyl, quinoxalyl, dibenzofuril, carbazolyl, xanthenyl, acridinyl, phenanthridinyl, phenanthryl, phenazinyl, phenoxazinyl, thianthrenyl, indolizinyl, quinolizinyl, naphthyridinyl, purinyl, puritedinyl, oxadiazolyl, oxathiazolyl, >C=C<, >C=N-, -N=N-, -N(R)-, -O-, -S-, -SO-, $-SO_2-$, -Si(R2)-, >C=Si<, -C≡C-, and -B(R)-.

According to a seventh aspect of the present invention, there is provided an electro luminescent element comprising one or more organic compound layers between the electrodes, wherein at least one of the organic compound layer is an adamantane derivative represented by the following chemical formula,



in which R1 through R8 represent substituents, and Ar1 and Ar2 represent functional units having hole transporting ability, luminescence, and electron transporting ability.

According to the structure mentioned above, the organic compound layer is a compound having the adamantane derivative as its main skeleton and the adamantane derivative is a rigid molecule with a good heat endurance. By introducing substituents on R1 through R8, rotation around the connecting axes between the adamantane and benzene ring and between the benzene ring and the substituent unit are constrained, so that the movability and internal rotation of the molecule is reduced, resulting in improvemed heat endurance compared to a case without substituents.

According to an eighth aspect of the present invention, there is provided an electro luminescent element with the structure of the seventh aspect, wherein the adamantane derivative is distributed among host materials and the host material is further layered in the organic compound layers.

According to a ninth aspect of the present invention, there is provided an electro luminescent element with the structure of the seventh aspect, wherein the substituents R1 through R8 are substituted with a functional group including alkyl group, aryl group, allyl group, alkene group, alkyne group, alkoxy group, hydroxyl group, hydroxylate group, thiocarboxy group, dithiocarboxy group, sulfo group, sulfino group, sulfeno group, oxycarbonyl group, haloformyl group, carbamoyl group, hydrazinocarbonyl group, amidino group, cyano group, isocyano group, cyanato group, isocyanato group, thiocyanato group, isothiocyanato group, formyl group, oxo group, thioformyl group, thioxo group, mercapto group, amino group, imino group, hydrazino group, aryloxy group, sulfide group, halogen group, nitro group, and silyl group.

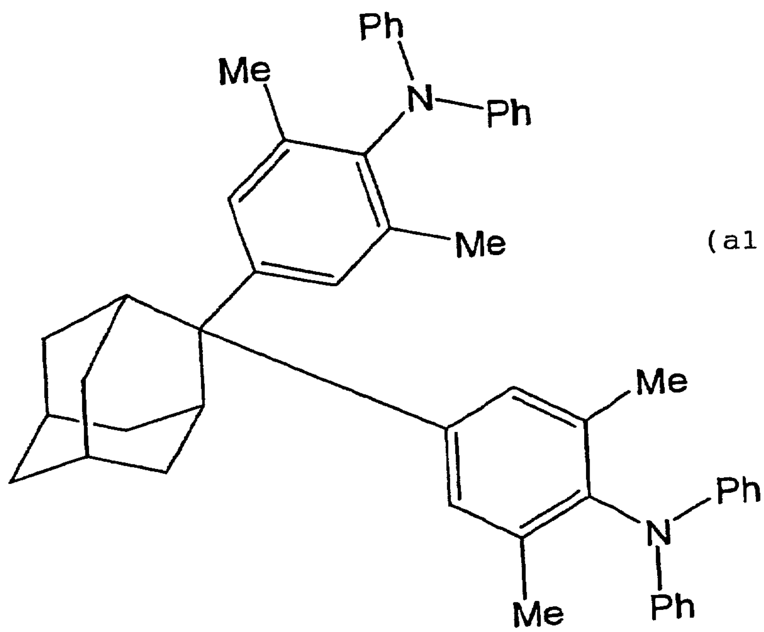
According to an tenth aspect of the present invention, there is provided an electro luminescent element with the structure of the seventh aspect, wherein each of the functional units Ar1 and Ar2 has an aryl skeleton as a basic slelton.

According to a eleventh aspect of the present invention, there is provided an electro luminescent element with the structure of the tenth aspect, wherein the aryl skelton is selected from the

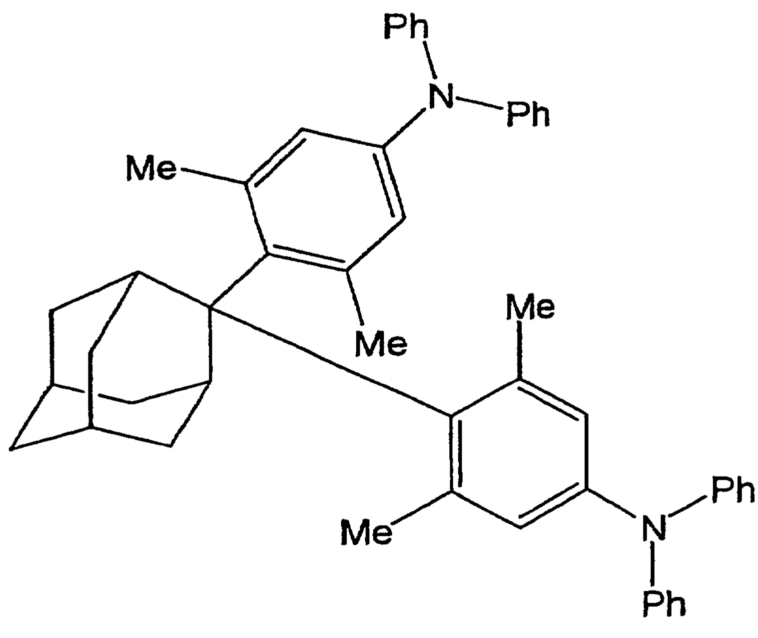
group of consisting of phenyl, naphthyl, and phenanthryl.

According to a twelfth aspect of the present invention, there is provided an electro luminescent element with the structure of the tenth aspect, wherein the functional units Ar1 and Ar2 is further substituted by functional groups including alkyl group, aryl group, allyl group, alkene group, alkyne group, alkoxy group, hydroxyl group, hydroxylate group, thiocarboxy group, dithiocarboxy group, sulfo group, sulfino group, sulfeno group, oxycarbonyl group, haloformyl group, carbamoyl group, hydrazinocarbonyl group, amidino group, cyano group, isocyano group, cyanato group, isocyanato group, thiocyanato group, isothiocyanato group, formyl group, oxo group, thioformyl group, thioxo group, mercapto group, amino group, imino group, hydrazino group, aryloxy group, sulfide group, halogen group, nitro group, and silyl group.

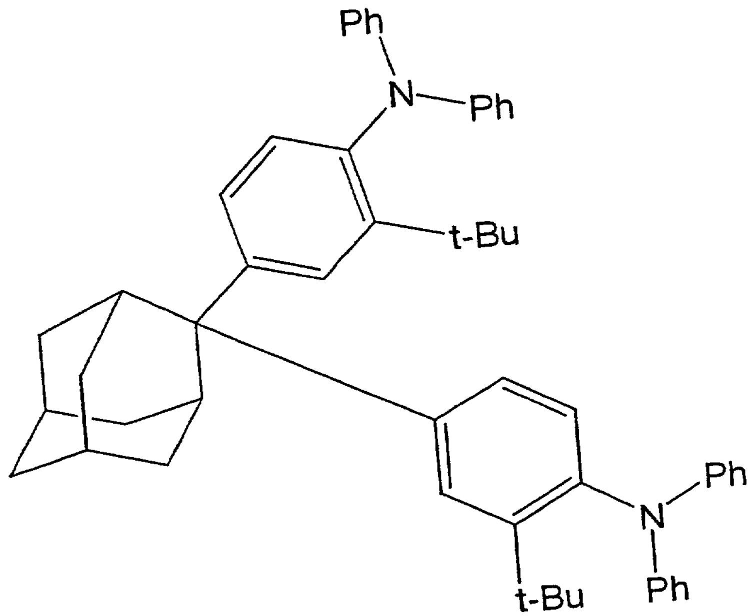
According to a thirteenth aspect of the present invention, there is provided an electro luminescent element with the structure of the seventh aspect, wherein the adamantane derivative has a structure represented by the following formulae, (a1) ~ (a13).



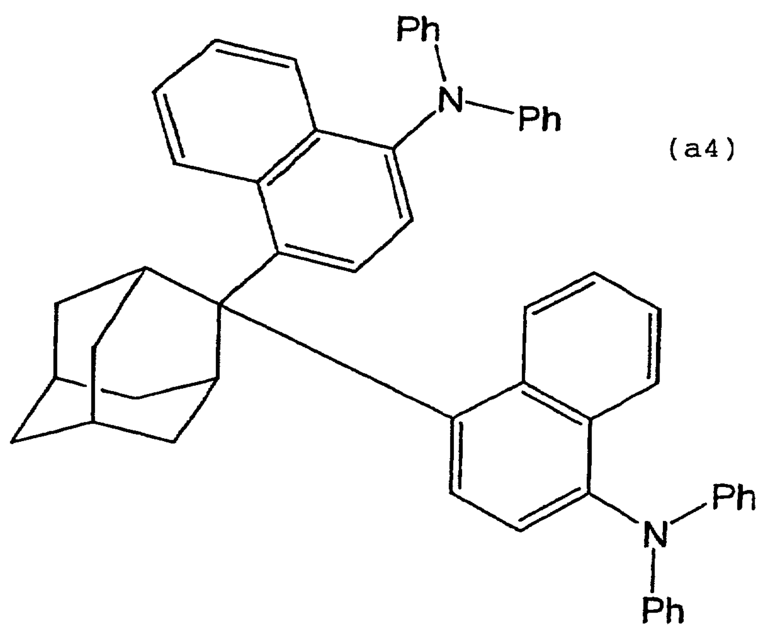
(a1)



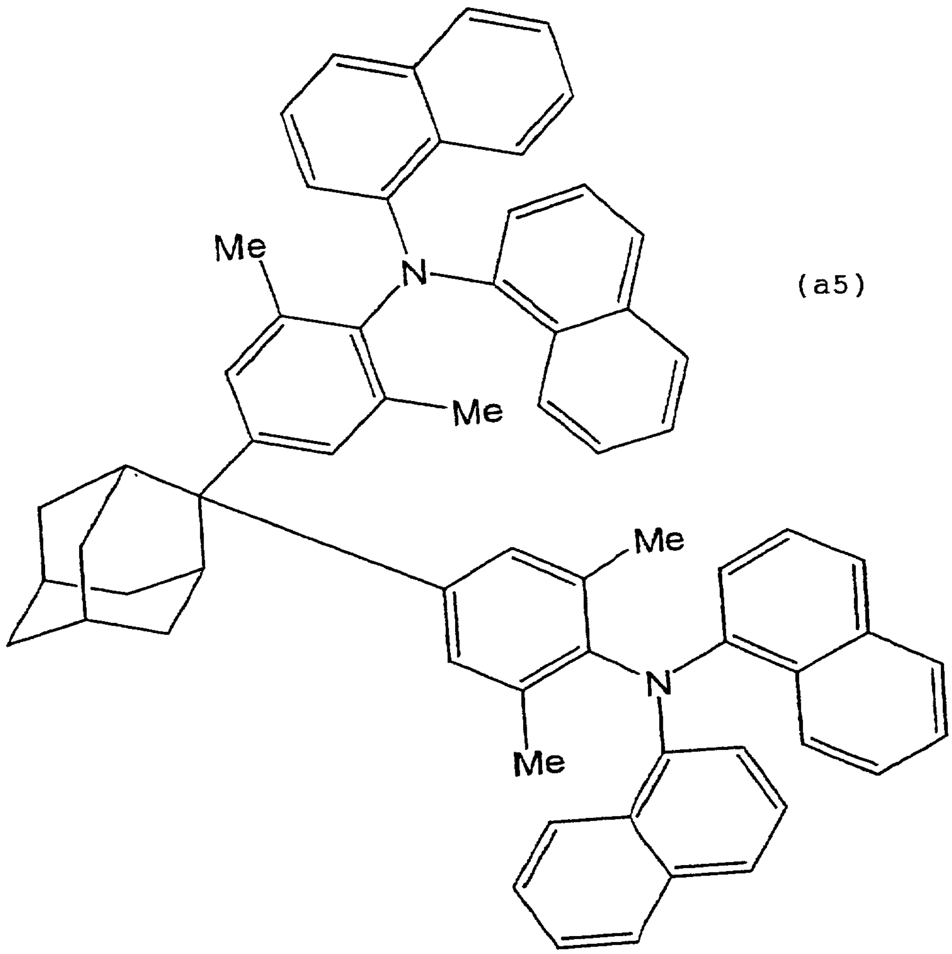
(a2)



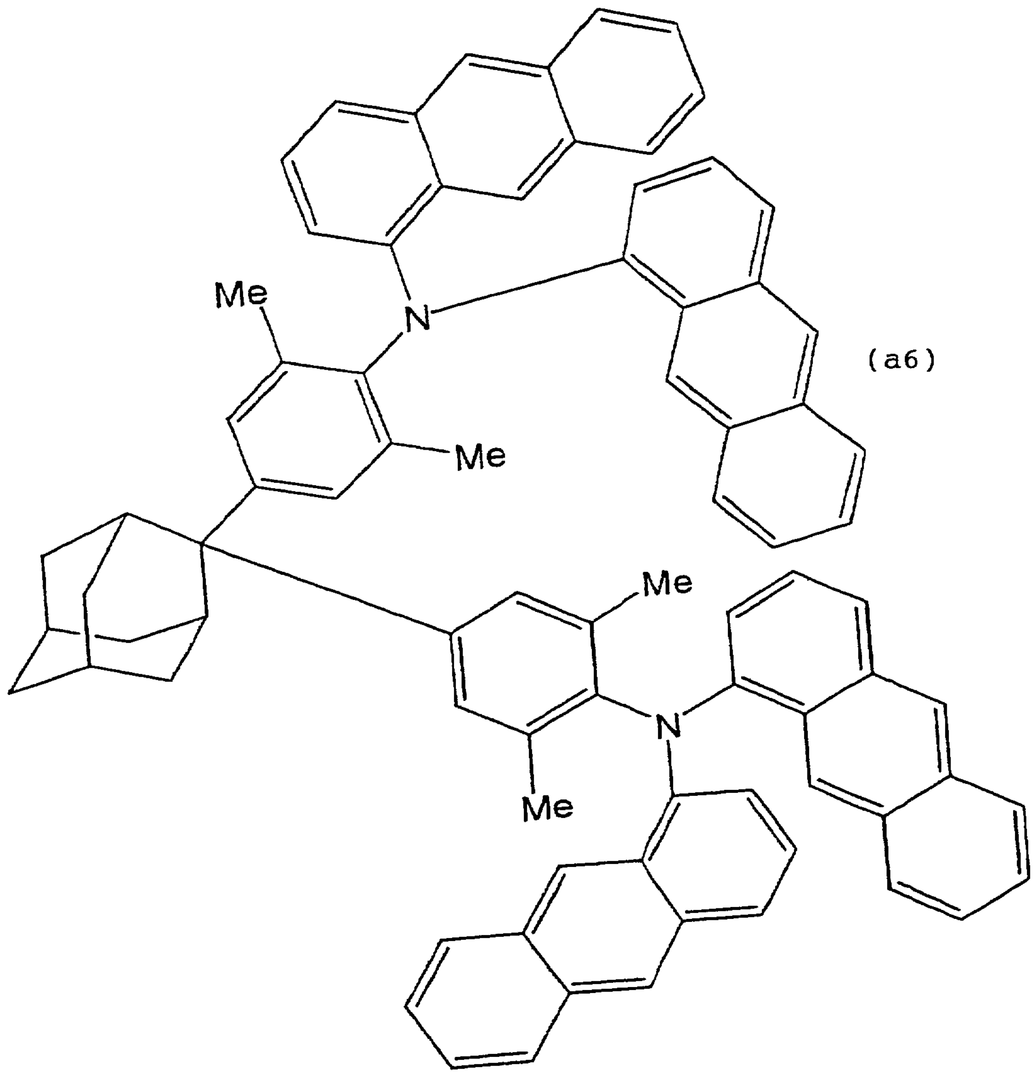
(a3)



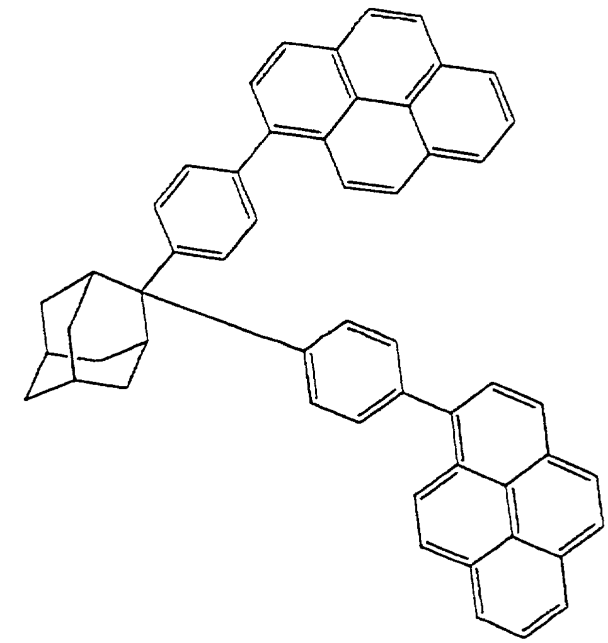
(a4)



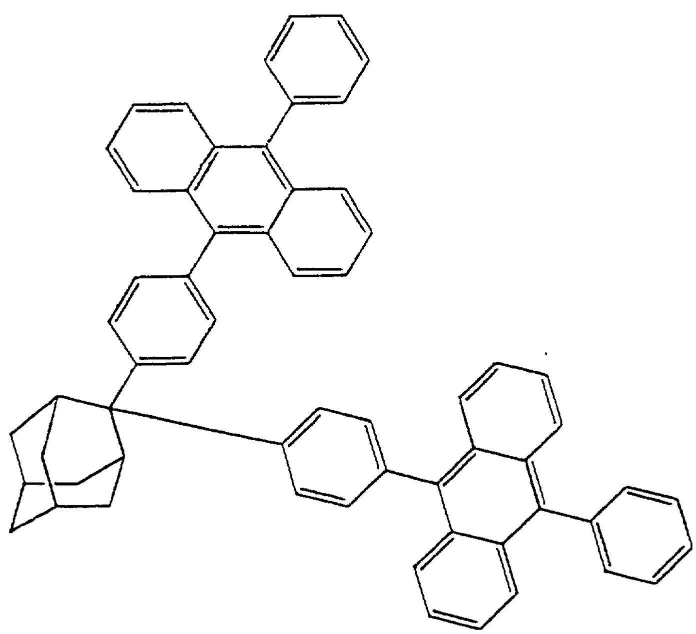
(a5)



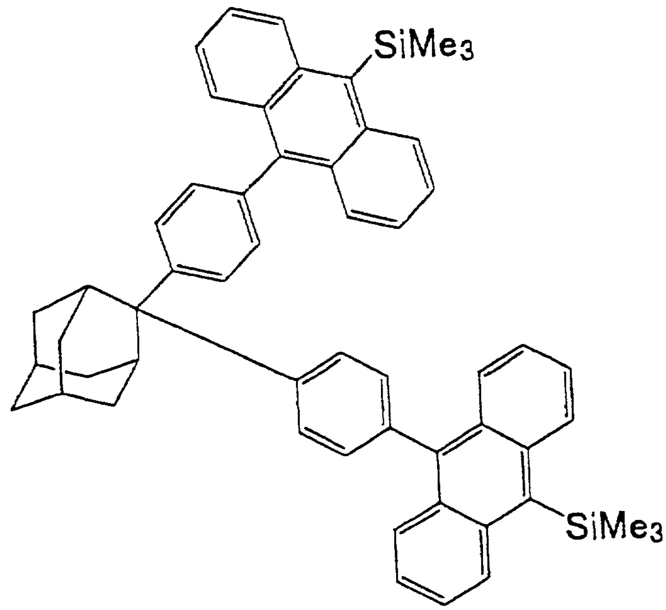
(a6)



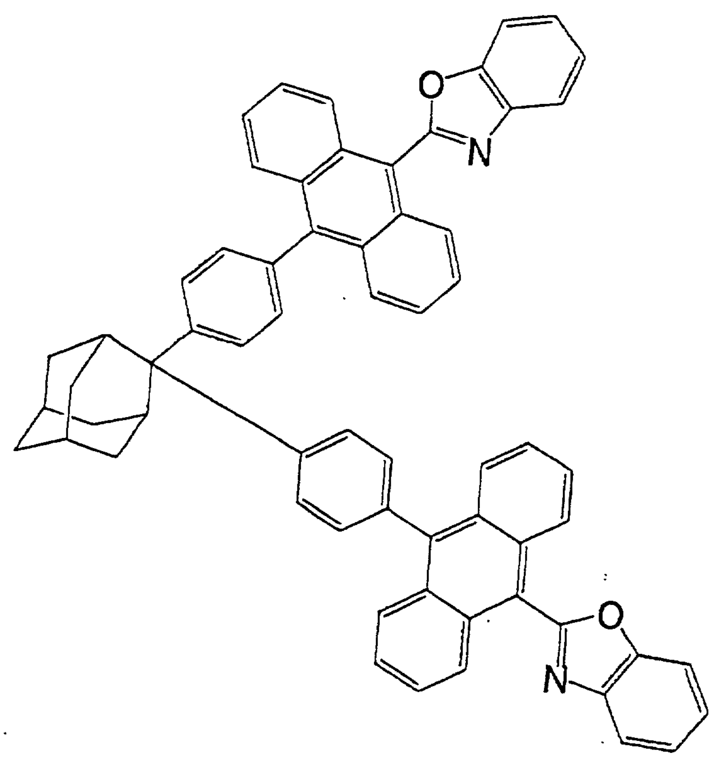
(a7)



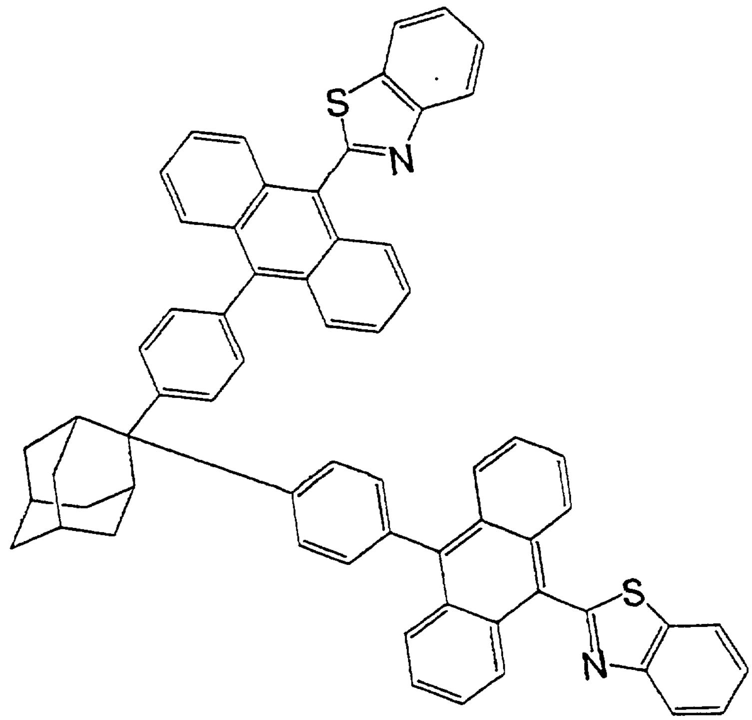
(a8)



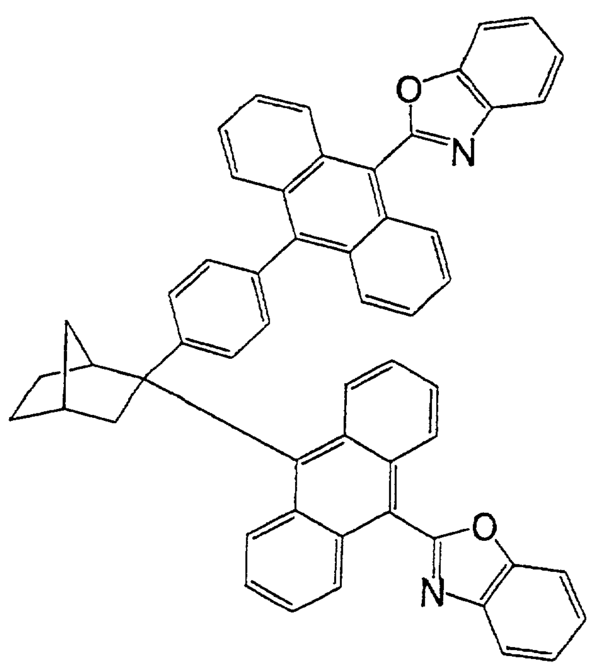
(a9)



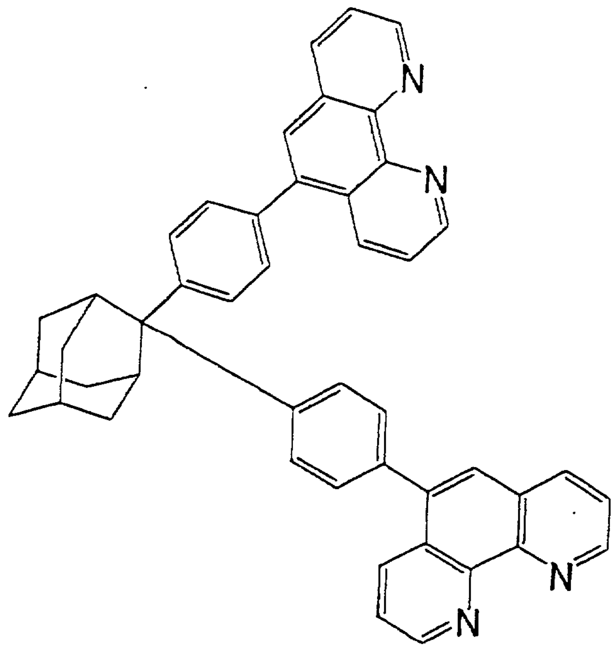
(a10)



(a11)



(a12)



(a13)

BRIEF DESCRIPTION OF THE DRAWING

Fig. 1 is a cross sectional diagram schematically showing a structure of an electro luminescent element according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the present invention (hereinafter referred to as embodiments) are described hereinafter referring to the accompanying diagram.

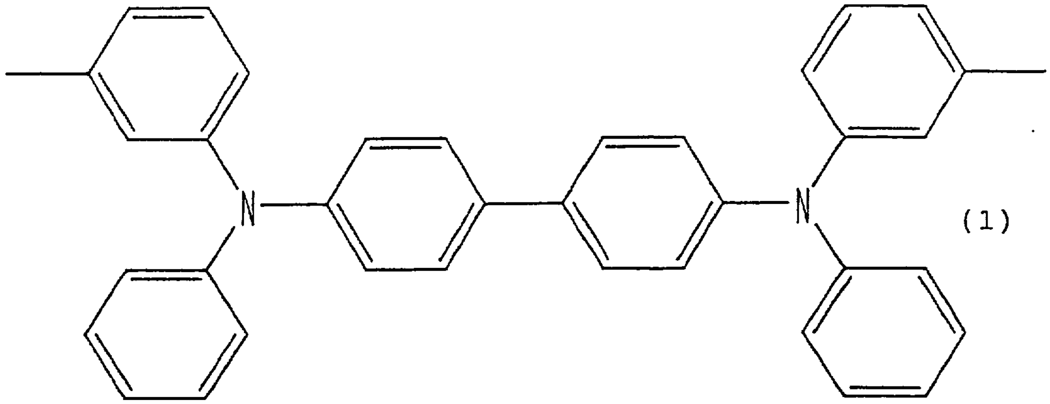
Embodiment 1

Fig. 1 is a cross sectional diagram schematically showing a structure of an electro luminescent element according to a first embodiment of the present invention. In Fig. 1, the electro luminescent element is constructed by sequentially layering a first

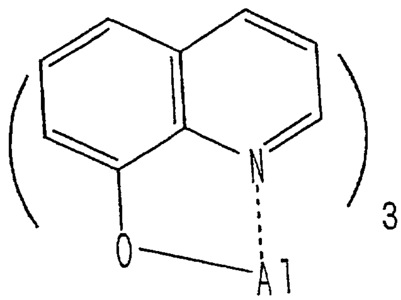
electrode 12 which is an anode on a transparent substrate 10, an organic compound layer 14 which emits light when electric field is applied, and a second electrode 16 which is a cathode.

The material for constructing the transparent substrate 10 includes, but not limited to, a glass substrate, a transparent ceramics substrate, and a diamond substrate. As the first electrode 12, a transparent electrode having high light permeability and conductivity is used. For example, a thin film material such as ITO (indium tin oxide), SnO_2, InO_3, and polyaniline can be used. As the second electrode 16, a metal having a low ionization potential such as Li, B, Be, Na, Mg, Al, K, Ca, and Ag, or an alloy including these metals such as MgAg, LiAl, and LiF/Al can be used.

The organic compound layer 14 provided between the first electrode 12 and the second electrode 16 is a thin film with an uniform thickness (few tens to few thousands of nm), constructed mainly from an organic compound. The organic compound layer 14 has a structure including a condensed ring compound derivative layer or a structure in which the condensed ring compound is distributed among materials which act as hosts and the host materials are further layered in the organic compound layer 14. The material acting as a host includes, for example, TPD represented by a chemical formula (1) and Alq3 represented by a chemical formula (2).



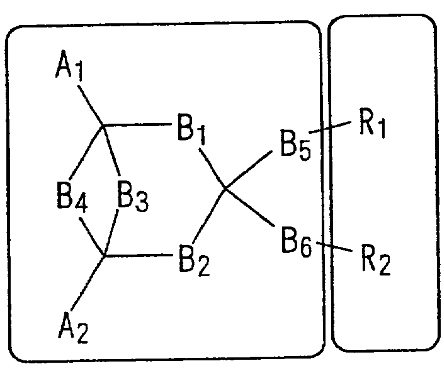
(1)



(2)

The condensed ring compound derivative mentioned here is a compound represented by a general chemical formula (3).

CONDENSED RING SECTION FUNCTIONAL UNIT SECTION



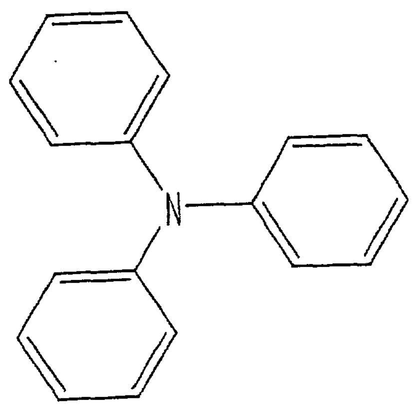
(3)

In these formula, A1 and A2 represent substituents. The substituents can be substituted by a functional group including alkyl group, aryl group, allyl group, alkene group, alkyne group, alkoxy group, hydroxyl group, hydroxylate group, thiocarboxy group, dithiocarboxy group, sulfo group, sulfino group, sulfeno group, oxycarbonyl group, haloformyl group, carbamoyl group, hydrazinocarbonyl group, amidino group, cyano group, isocyano group, cyanato group, isocyanato group, thiocyanato group, isothiocyanato group, formyl group, oxo group, thioformyl group, thioxo group, mercapto group, amino group, imino group, hydrazino group, aryloxy group, sulfide group, halogen group, nitro group, and silyl group.

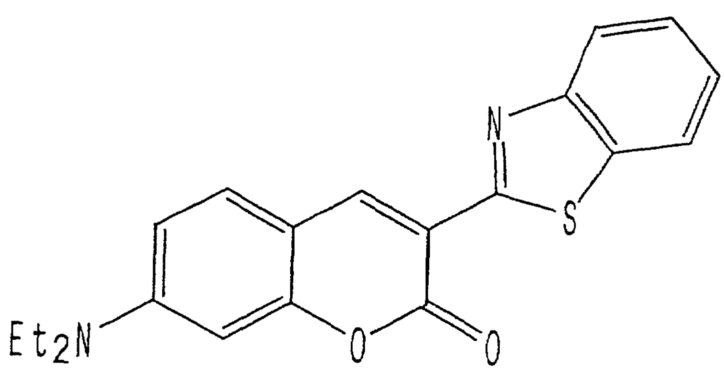
B1 through B6 represent directly combined or bi functional substituents and are substituents constructed from constructing elements including alkyl group, aryl group, allyl group, alkene group, alkyne group, alkoxy group, hydroxyl group, hydroxylate group, thiocarboxy group, dithiocarboxy group, sulfo group, sulfino group, sulfeno group, oxycarbonyl group, haloformyl group, carbamoyl group, hydrazinocarbonyl group, amidino group, cyano group, isocyano group, cyanato group, isocyanato group, thiocyanato group, isothiocyanato group, formyl group, oxo group, thioformyl group, thioxo group, mercapto group, amino group, imino group, hydrazino group, aryloxy group, sulfide group, halogen group, nitro group, and silyl group

R1 and R2 represent functional units having each of the functions of hole transporting, luminescence, and electron

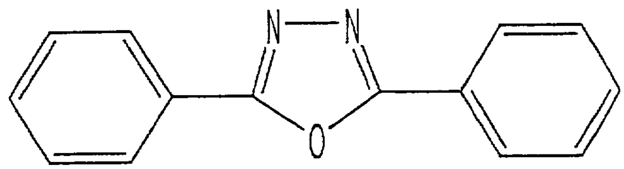
transporting. The example of functional units include, triphenylamine as a functional unit having hole transporting ability and represented by a chemical formula (4), coumarin as a functional unit having luminescence and represented by a chemical formula (5), and oxadiazole derivative as a functional unit having electron transporting ability and represented by a chemical formula (6), but any functional unit can be used having hole transporting, luminescence, and/or electron transporting functions.



(4)



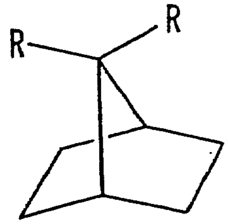
(5)



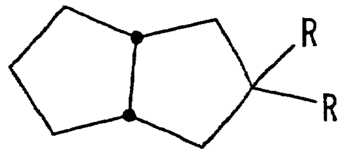
(6)

B1 through B4, R1, R2, A1, and A2 can be directly connected or connected by an aromatic ring or chain compound which is interconnected, and the connecting section can include any of the functional groups.

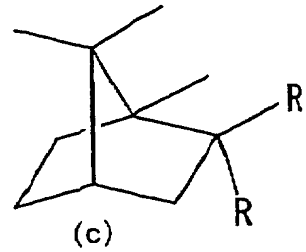
Examples of such a condensed ring compound derivative include compounds represented by the following chemical formulae (a) through (l). In these formulae, the functional units R1 and R2 are both represented by "R".



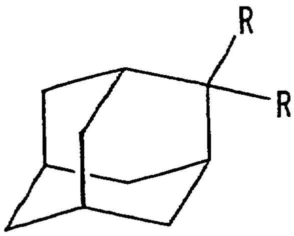
(a)



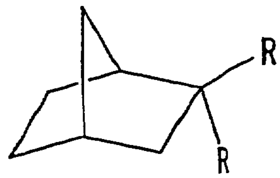
(b)



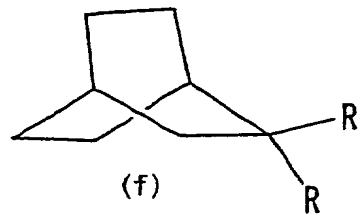
(c)



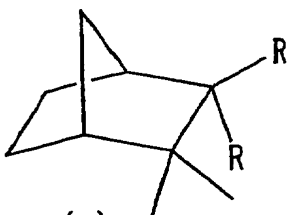
(d)



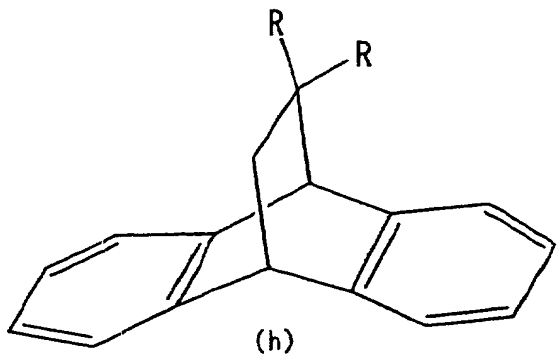
(e)



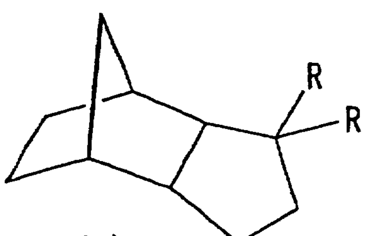
(f)



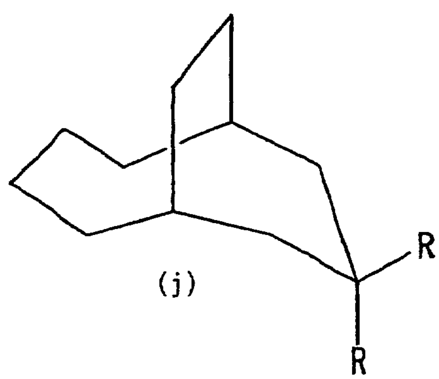
(g)



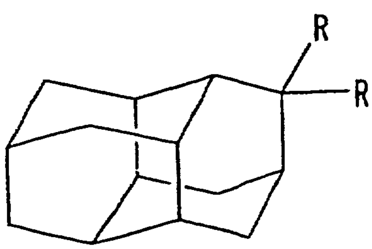
(h)



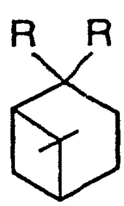
(i)



(j)

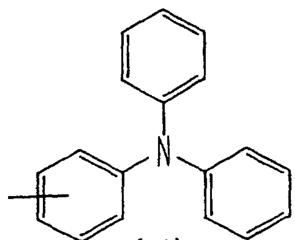


(k)

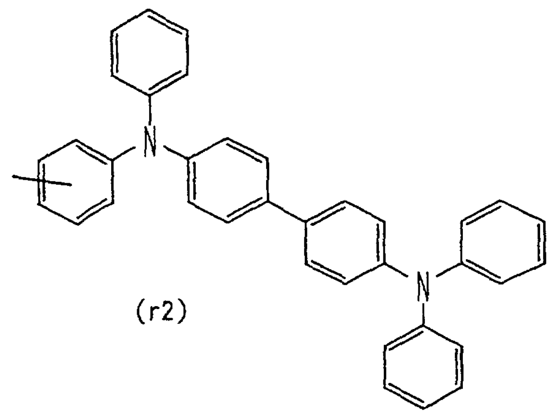


(l)

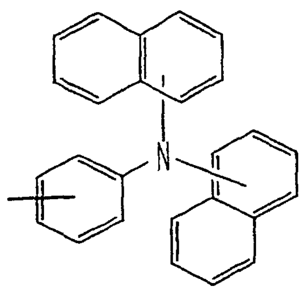
Examples of the functional units R1 and R2 include the compounds represented by the following chemical formulae (r1) through (r9).



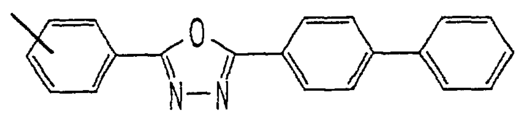
(r1)



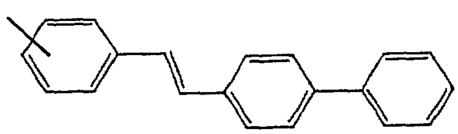
(r2)



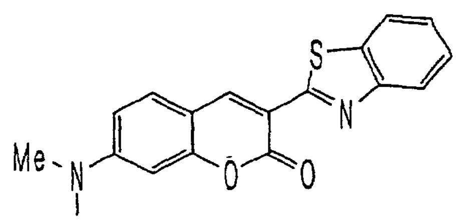
(r3)



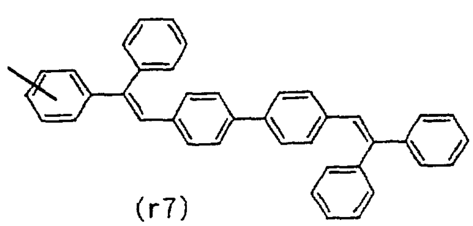
(r4)



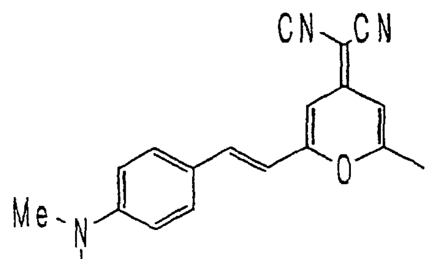
(r5)



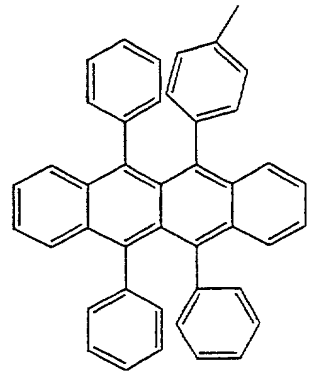
(r6)



(r7)

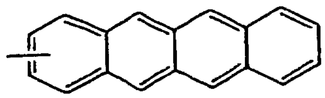


(r8)

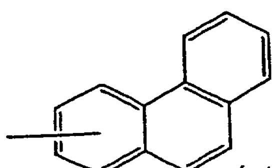


(r9)

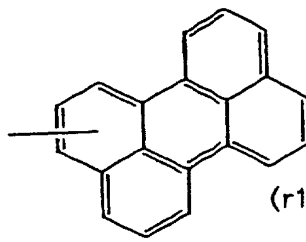
Examples of functional units R1 and R2 can further include the compounds represented by the following chemical formulae (r10) through (r22),



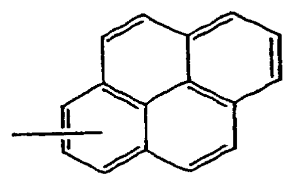
(r10)



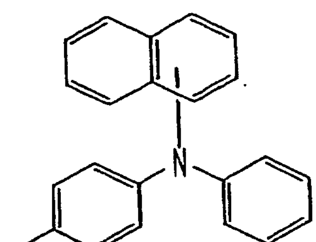
(r11)



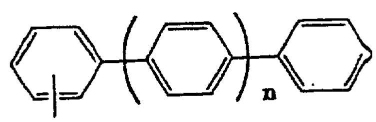
(r12)



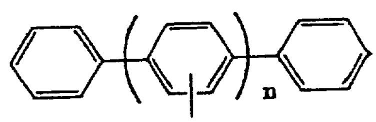
(r13)



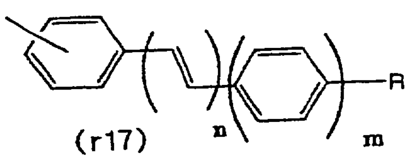
(r14)



(r15)

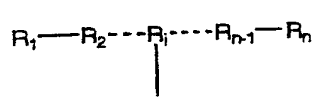


(r16)

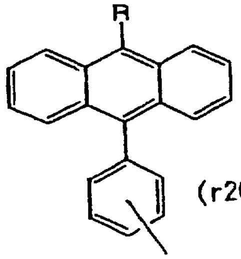


(r17)

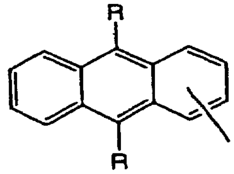
$-R_1-R_2---R_{n-1}-R_n$ (r18)



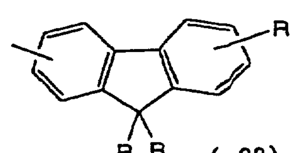
(r19)



(r20)



(r21)



(r22)

in which n, m, and i represent integers, R represents saturated hydrocarbon from C1 through C30, an isomer thereof, or an aromatic compound, such as phenyl, naphthyl, indenyl, fluorenyl, phenanthryl, anthranyl, pyrenyl, chrysenyl, naphthacenyl, benzophenanthrenyl, furanyl, thiophenyl, pyrrolyl, oxazolyl, isoxazolyl, pyrazolyl, triazolyl, furazalyl, pyridyl, oxazyl, morpholyl, thiazyl, pyridazyl, pyrimidyl, pyrazyl, triazyl, benzofuryl, isobenzofuryl, benzothiophenyl, indolyl, isoindolyl, benzoxazolyl, benzothiazolyl, benzoimidazolyl, chromelyl, quinolyl, isoquinolyl, cinnolyl, phthalazyl, quinazolyl, quinoxalyl, dibenzofuril, carbazolyl, xanthenyl, acridinyl, phenanthridinyl, phenanthryl, phenazinyl, phenoxazinyl, thianthrenyl, indolizinyl, quinolizinyl, naphthyridinyl, purinyl, puritedinyl, oxadiazolyl, oxathiazolyl, >C=C<, >C=N-, -N=N-, -N(R)-, -O-, -S-, -SO-, $-SO_2-$, -Si(R2)-, >C=Si<, and $-C\equiv C-$.

The functional molecules having hole transporting ability, luminescence, and electron transporting ability, have a high crystallinity due to its general planer shape and good symmetry, and easily transform from a substable non-crystalline condition to crystallized condition by heat. By using condensed ring compound derivative as these compounds, the molecule can have a non-planer structure and reduced molecular symmetry. In this manner, the crystallinity of the molecule can be reduced. On the other hand by using a condensed ring compound, a rigid molecule skeleton of the condensed ring compound can be introduced to reduce

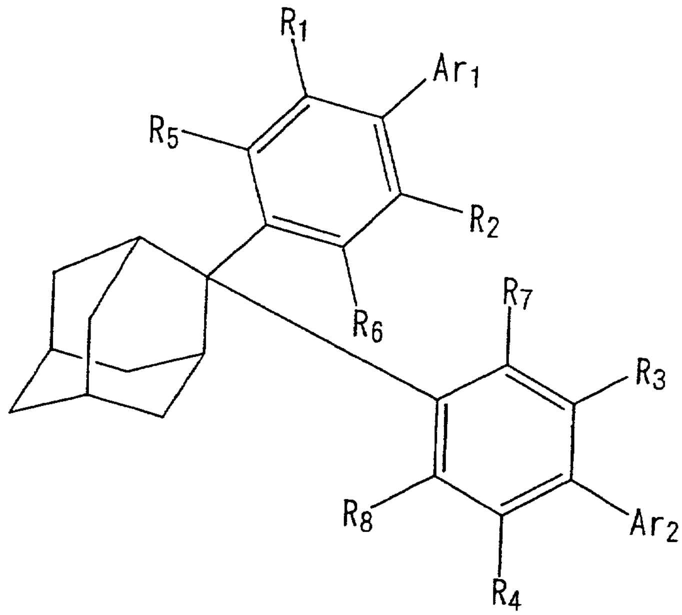
the movability of the molecule, resulting in improvements in heat endurance.

In this manner, by using condensed ring compound derivatives for functional molecules having each of the functions of the hole transporting, luminescence, and electron transporting, low crystallinity and high heat endurance, both of which are preferable characteristics as materials for an organic electro luminescent element, can be added while maintaining superior electric characteristics.

Embodiment 2

The second preferred embodiment of the present invention has a structure such that either an adamantane derivative layer is included in the organic compound layer 14 of the electro luminescent element shown in Fig. 1 or the adamantane derivative is distributed among materials that act as hosts with the hosts further layered in the organic compound layer 14. Examples of the material that acts as a host include TPD represented by (1) and Alq3 represented by (2).

Here, the adamantane derivative is a compound represented by the following general chemical formula (7).



(7)

Ar1 and Ar2 represent substituents and composed of compounds with hole transporting ability, luminescence, and electron transporting ability. The substituents have the basic skeleton as an aryl skeleton such as phenyl, naphthyl, and phenanthryl. The substituents can further be substituted by, for example, a functional group selected from a group of alkyl group, aryl group, allyl group, alkene group, alkyne group, alkoxy group, hydroxyl group, hydroxylate group, thiocarboxy group, dithiocarboxy group, sulfo group, sulfino group, sulfeno group, oxycarbonyl group, haloformyl group, carbamoyl group, hydrazinocarbonyl group, amidino group, cyano group, isocyano group, cyanato group, isocyanato group, thiocyanato group, isothiocyanato group, formyl group, oxo group, thioformyl group, thioxo group, mercapto group, amino group, imino group, hydrazino group, aryloxy group, sulfide group, halogen group, nitro group, and silyl group.

R1 through R8 represent substituents and can be, for example,

functional groups including alkyl group, aryl group, allyl group, alkene group, alkyne group, alkoxy group, hydroxyl group, hydroxylate group, thiocarboxy group, dithiocarboxy group, sulfo group, sulfino group, sulfeno group, oxycarbonyl group, haloformyl group, carbamoyl group, hydrazinocarbonyl group, amidino group, cyano group, isocyano group, cyanato group, isocyanato group, thiocyanato group, isothiocyanato group, formyl group, oxo group, thioformyl group, thioxo group, mercapto group, amino group, imino group, hydrazino group, aryloxy group, sulfide group, halogen group, nitro group, and silyl group.

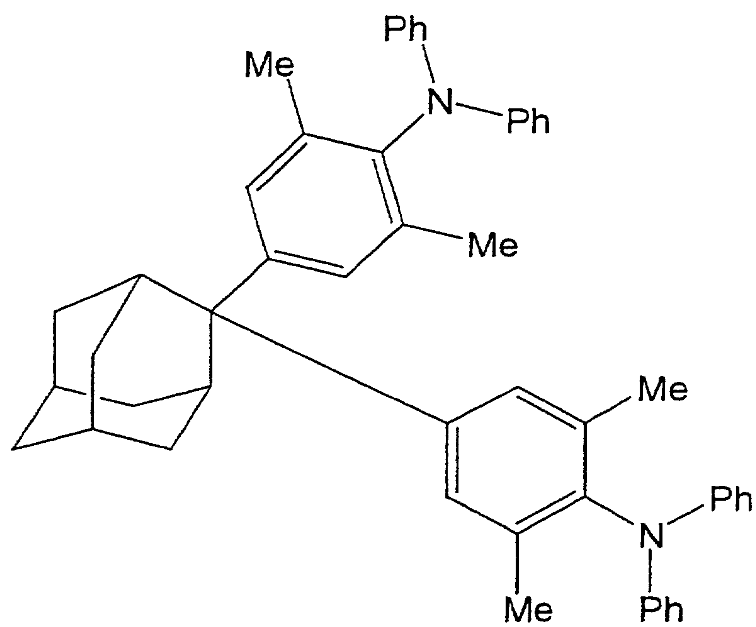
Connection between Ar1 and Ar2 and interconnection between R1 through R8 can be achieved by directly connecting or by connecting using 2 functional substituents. The connection section can include any of the functional groups mentioned above.

As described above, a compound according to the present invention has an adamantane derivative as its basic skeleton.

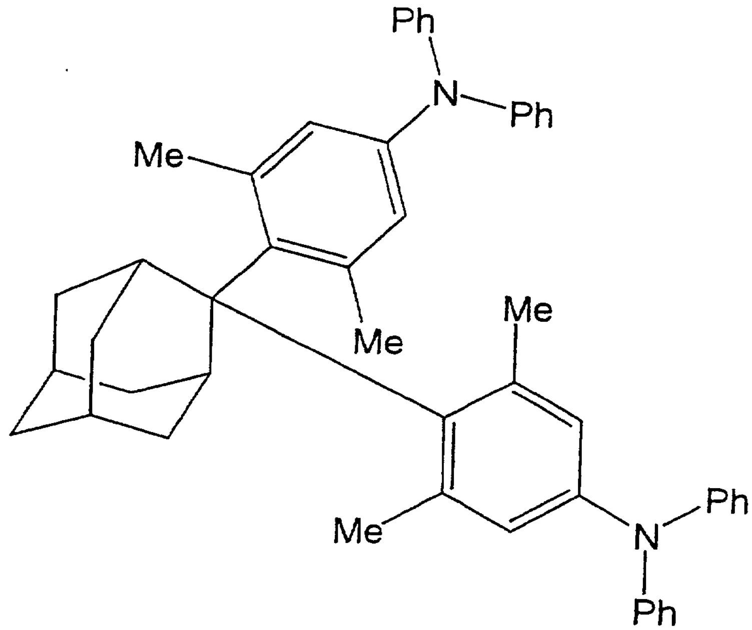
The adamantane skeleton has a high strength and high heat endurance, as can be seen from its ability to stably sublimate at a temperature greater than or equal to 200 ℃. The adamantane derivative according to the present invention has the adamantane skeleton within the molecule as a cross-linkage point. Because of this, the molecule is fixed with high strength and rigidness and with a good heat enduring ability.

By introducing substituents in R1 through R8, heat endurance and endurance improve compared to a case without the substituents.

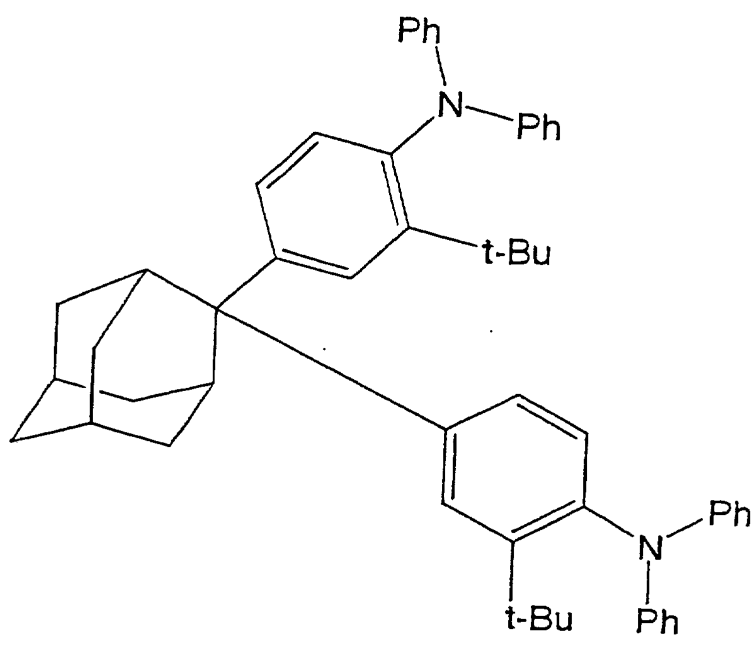
By introducing the substituents, rotations around the connecting axes between the adamantane and benzene ring and between the benzene ring and substituent molecule are constrained, resulting in decrease in the movability of the molecule and thus improvements in heat endurance. As a substitute, a substitute with a size of methyl group is sufficiently effective, as shown in the following (8) and (9), but the heat endurance improvement is more effective if a substituent with a higher mass such as t-Bu and triphenylsilyl group etc., as shown in (10) is introduced.



(8)

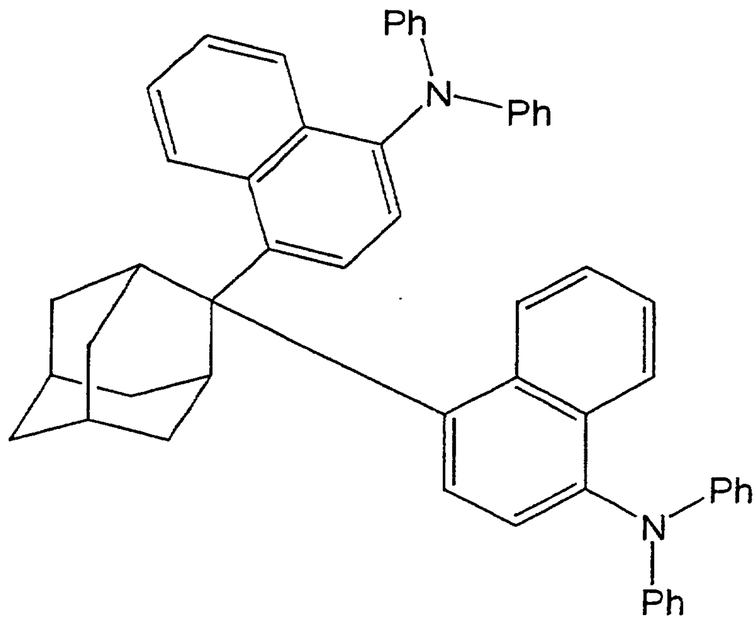


(9)



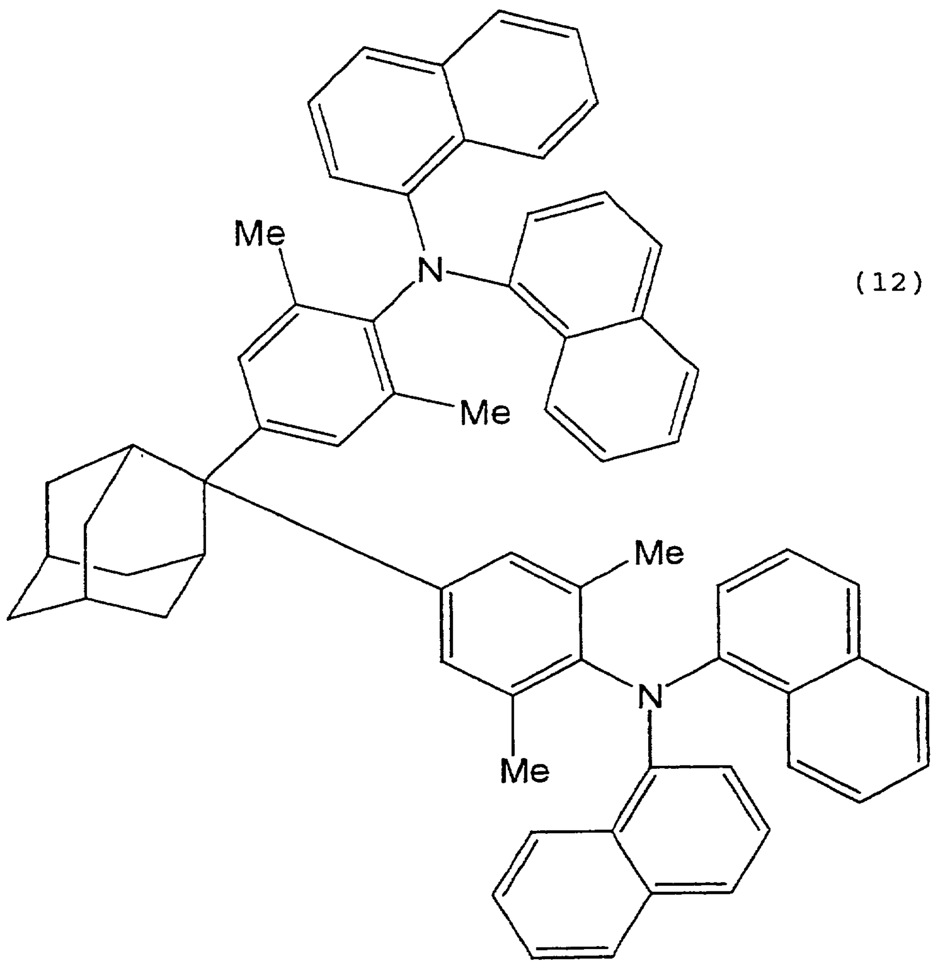
(10)

Similarly, rotation of compounds with the benzene ring section replaced by a naphthalene ring, represented by following (11), is constrained, resulting in an improvement in the heat endurance when compared to a case without substituents.

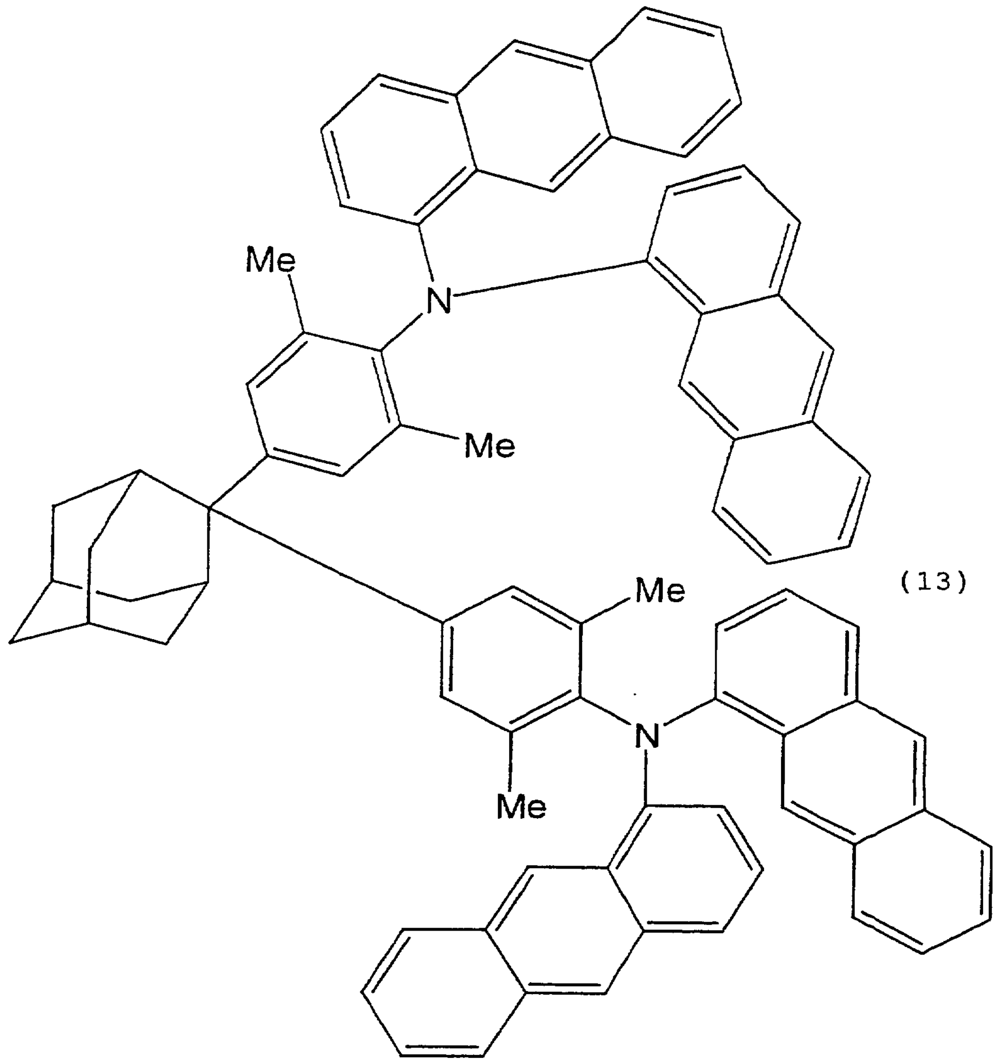


(11)

As can be seen from following (12) and (13), by increasing the degree of condensing from diphenylamine to dinaphthylamine and dianthranilamine, the ionization potential as a hole transporting material is decreased, so that hole can more easily be injected from the transparent electrode, resulting in an improvement in the luminescence of the electro luminescent element. At the same time, rotation of the molecule is constrained, thus the structure effectively improves the heat endurance.



(12)



(13)

These compounds can be synthesized generally by a coupling reaction between an adamantane amine compound and aromatic halogen compound, or by a coupling reaction between an adamantane halogen

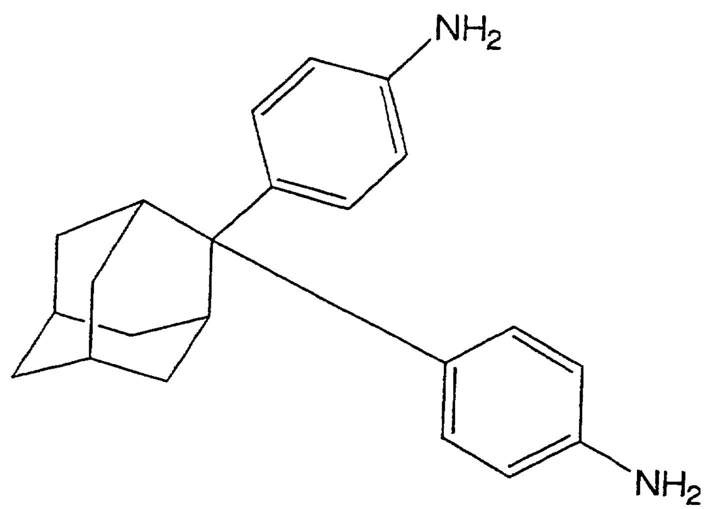
compound, adamantane borate, adamantane sulfonyl ether, adamantane ether, or adamantane ester and aromatic amine compound, but the obtaining method is not limited to these.

Experiment

Comparative experimental examples are described below, where an adamantane derivative was synthesized, an electro luminescent element was produced using the adamantane derivative, and the performance was examined.

[Example 1] Synthesis of dianilinoadamantane (14)

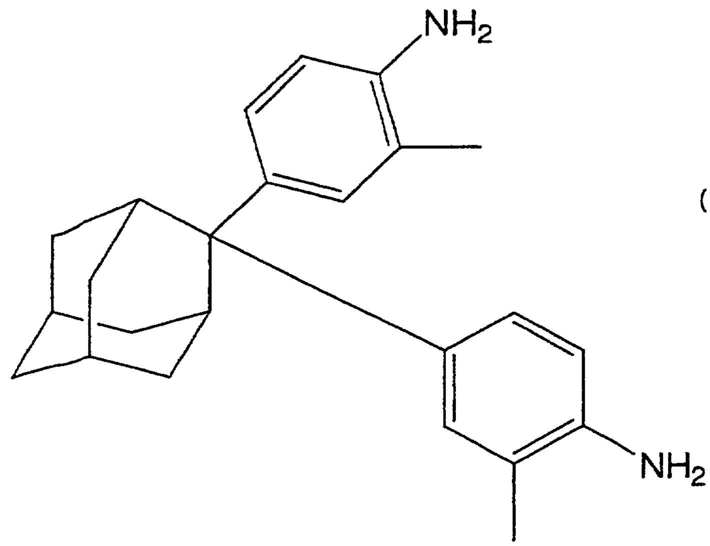
A mixture of 13 g of 2-adamantanone, 55 g of aniline, and 15 g of aniline hydrochloride was introduced to a flask with a water remover. The mixture was heated and refluxed at 200 ℃ (oil bath) under nitrogen atmosphere. Forty hours later, a KOH solution was added so that the pH was approximately 10, and the mixture was extracted with chloroform and washed with water. The mixture was then dried with sodium sulfate, evaporated, and purified with silica gel column chromatography, to obtain 5 g of dianilinoadamantane as a colorless amorphous material.



(14)

[Example 2] Synthesis of ditoluidinoadamantane (15)

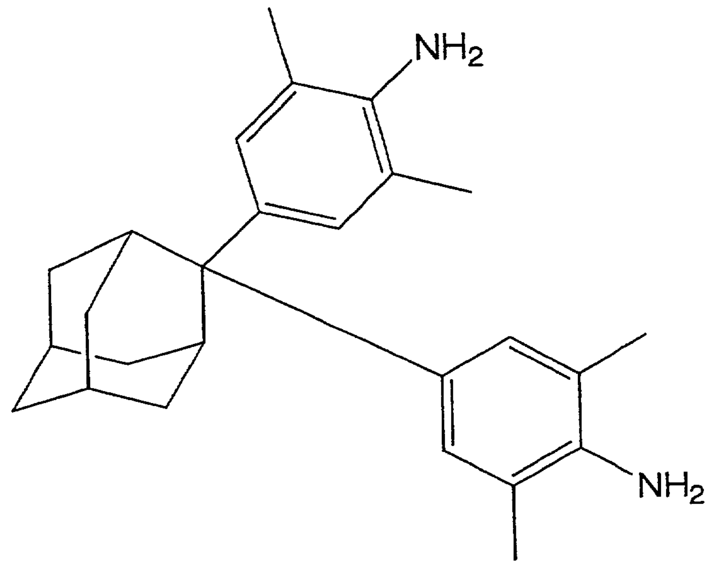
A mixture of 13 g of 2-adamantanone, 60 g of o-toluidine, and 18 g of o-toluidine hydrochloride was introduced to a flask with a water remover. The mixture was heated and refluxed at 250 ℃ (oil bath) under nitrogen atmosphere. Sixty hours later, a KOH solution was added so that the pH was approximately 10, and the mixture was extracted with chloroform and washed with water. The mixture was then dried with sodium sulfate, evaporated, and purified with silica gel column chromatography, to obtain 4.2 g of ditoluidinoadamantane as a white solid.



(15)

[Example 3] Synthesis of didimethylanilinoadamantane (16)

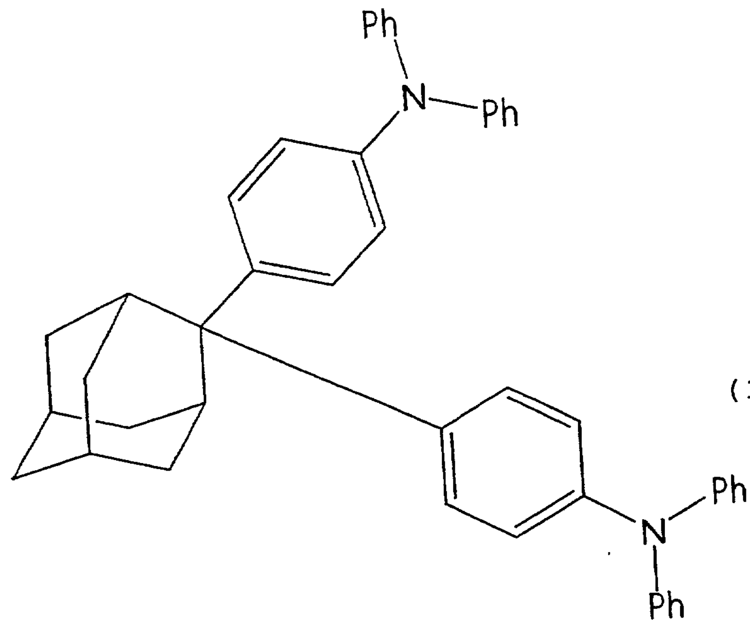
A mixture of 13 g of 2-adamantanone, 63 g of 2,6-dimethylaniline, and 20 g of 2,6-dimethylaniline hydrochloride was introduced to a flask with a water remover. The mixture was heated and refluxed at 250 ℃ (oil bath) under nitrogen atmosphere. Eighty hours later, a KOH solution was added so that the pH was approximately 10, and the mixture was extracted with chloroform and washed with water. The mixture was then dried with sodium sulfate, evaporated, and purified with silica gel column chromatography, to obtain 6.5 g of didimethylanilinoadamantane as a white solid.



(16)

[Example 4] Synthesis of a hole transporting molecule (17)

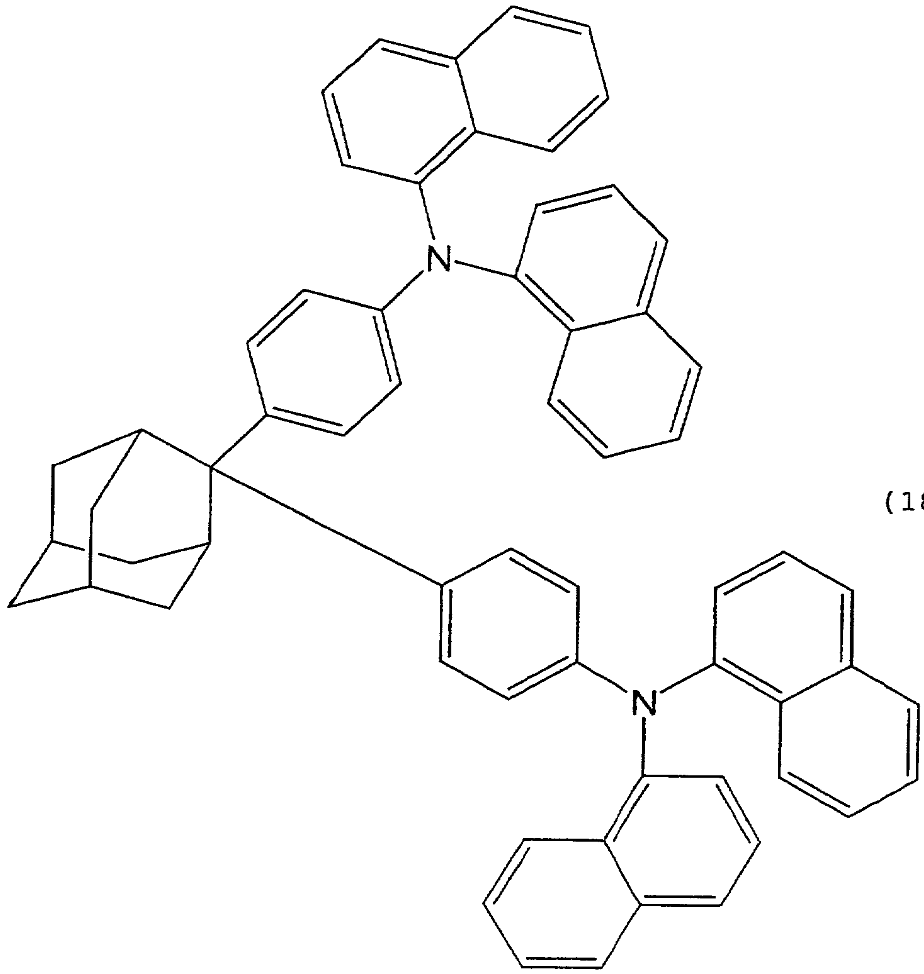
A mixture of 252 mg of dianilinoadamantane (compound 14), 1.0 g of iodobenzene, 1.1 g of potassium carbonate, 700 mg of copper powder, 250 mg of CuO, and 5 g of decalin was heated and stirred for 31 hours under nitrogen atmosphere at 170 ℃. The mixture was then purified by silica gel column chromatography (chloroform-hexane 1:1) to obtain 115 mg of a hole transporting molecule (17).



(17)

[Example 5] Synthesis of a hole transporting molecule (18)

A mixture of 253 mg of dianilinoadamantane (compound 14), 1.0 g of 1-iodonaphthalene, 1.1 g of potassium carbonate, 700 mg of copper powder, 270 mg of CuO, and 3.5 g of decalin was heated and stirred under nitrogen atmosphere for 30 hours at 170 ℃. The mixture was then purified by silica gel column chromatography (chloroform-hexane 1:1) to obtain 133 mg of a hole transporting molecule (18).

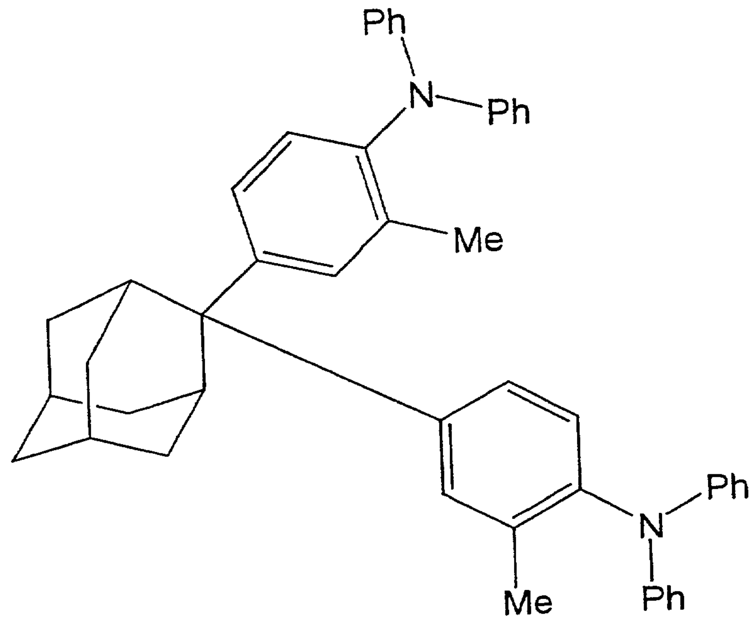


(18)

[Example 6] Synthesis of a hole transporting molecule (19)

A mixture of 250 mg of ditoluidinoadamantane (15), mentioned above, 1.0 g of iodobenzene, 1.1 g of potassium carbonate, 700 mg of copper powder, 250 mg of CuO, and 5 g of decalin was heated and stirred under nitrogen atmosphere for 35 hours at 170 ℃. The mixture was then purified by silica gel column chromatography (chloroform-hexane 1:1) to obtain 95 mg of hole transporting

molecule (19).



(19)

[Example 7] Synthesis of a hole transporting molecule (8)

A mixture of 252 mg of didimethylanilinoadamantane (16), mentioned above, 1.0 g of iodobenzene, 1.1 g of potassium carbonate, 700 mg of copper powder, 250 mg of CuO, and 5 g of decalin was heated and stirred under nitrogen atmosphere for 30 hours at 170 ℃. The mixture was then purified by silica gel column chromatography (chloroform-hexane 1:1) to obtain 75 mg of hole transporting molecule (8).

[Example 8] Glass transition temperatures of the hole transporting molecules

Glass transition temperatures of the hole transporting molecules (17), (18), (19), and (8) measured by differential scanning calorimeter (DSC) were respectively 110 ℃, 135 ℃, 150 ℃, and 165 ℃.

[Comparative Example 1] Glass transition temperature of a hole transporting molecule

The glass transition temperature of TPD measured by differential scanning calorimeter (DSC) was 65 ℃.

[Example 9]

An electro luminescent element was prepared as follows using the hole transporting molecule (17) mentioned above. An ITO electrode was formed on a glass substrate and the hole transporting molecule (17) was vacuum evaporated with a thickness of 60 nm as a hole transporting layer. 60 nm of Alq_3, which is the electron transporting molecule was co-evaporated on top of this layer. Finally, a Mg/Ag electrode (9:1) was evaporated to produce an electro luminescent element. The element was driven under nitrogen gas atmosphere at room temperature. When an electric current of 10 mA/cm^2 was injected, green color luminescence having a luminance of 150 cd/m^2 was obtained with a half life of luminance of 1000 hours.

[Example 10]

An electro luminescent element was prepared as follows using the hole transporting molecule (17) defined above. An ITO electrode was formed on a glass substrate and the hole transporting molecule (17) was vacuum evaporated with a thickness of 60 nm as

a hole transporting layer. 60 nm of Alq_3 as the electron transporting molecule was co-evaporated on top of this layer. Finally, a Mg/Ag electrode (9:1) was evaporated to produce an electro luminescent element. The element was driven in a nitrogen gas atmosphere at room temperature. When an electric current of 10 mA/cm^2 was injected, green color luminescence having a luminance of 150 cd/m^2 was obtained with the half life of luminance being 1000 hours. Temperature was raised while driving the element at 10 mA/cm^2. The element breakdown occurred at 110 ℃.

[Example 11]

An electro luminescent element was prepared as follows using the hole transporting molecule (18) mentioned above. An ITO electrode was formed on a glass substrate and the hole transporting molecule (18) was vacuum evaporated with a thickness of 60 nm as a hole transporting layer. 60 nm of Alq_3 as the electron transporting molecule was co-evaporated on top of this layer. Finally, a Mg/Ag electrode (9:1) was evaporated to produce an electro luminescent element. The element was driven in a nitrogen gas atmosphere at room temperature. When an electric current of 10 mA/cm^2 was injected, green color luminescence having a luminance of 200 cd/m^2 was obtained with a half life of luminance of 1500 hours. Temperature was raised while driving the element at 10 mA/cm^2. The element breakdown occurred at 135 ℃.

[Example 12]

An electro luminescent element was prepared as follows using

the hole transporting molecule (19) defined above. An ITO electrode was formed on a glass substrate and the hole transporting molecule (19) was vacuum evaporated with a thickness of 60 nm as a hole transporting layer. 60 nm of Alq_3 as the electron transporting molecule was co-evaporated on top of this layer. Finally, a Mg/Ag electrode (9:1) was evaporated to produce an electro luminescent element. The element was driven in a nitrogen gas atmosphere at room temperature. When an electric current of 10 mA/cm^2 was injected, green color luminescence having a luminance of 200 cd/m^2 was obtained with a half life of luminance of 1800 hours. Temperature was raised while driving the element at 10 mA/cm^2. The element breakdown occurred at 150 ℃.

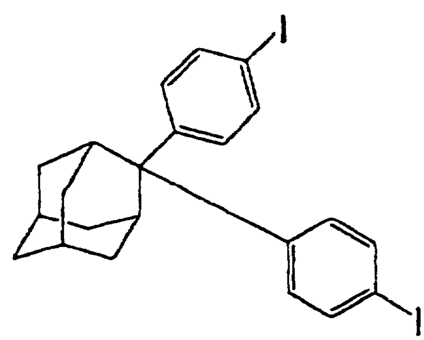
[Example 13]

An electro luminescent element was prepared as follows using the hole transporting molecule (8) defined above. An ITO electrode was formed on a glass substrate and the hole transporting molecule (8) was vacuum evaporated with a thickness of 60 nm as a hole transporting layer. 60 nm of Alq_3 as the electron transporting molecule was co-evaporated on top of this layer. Finally, a Mg/Ag electrode (9:1) was evaporated to produce an electro luminescent element. The element was driven in a nitrogen gas atmosphere at room temperature. When an electric current of 10 mA/cm^2 was injected, green color luminescence having a luminance of 190 cd/m^2 was obtained with a half life of luminance of 2200 hours. Temperature was raised while driving the element at 10 mA/cm^2. The

element breakdown occurred at 165 ℃.

[Example 14]

20 g of dianilinoadamantane (compound 14) was dissolved in a mixture of 50 ml of sulfuric acid and 20 ml of acetic acid. 5 g of sodium nitrite was added to the solution under ice cooling and stirring. 15 minutes later, 15 g of potassium iodide was added. After stirring the solution for 30 minutes under room temperature and reacting for one hour at 80 ℃, 500 ml of water was added, and the solution was filtered and washed with water. After recrystallizing with toluene, 12 g of diiodophenyladamanatane (compound 20) was obtained.



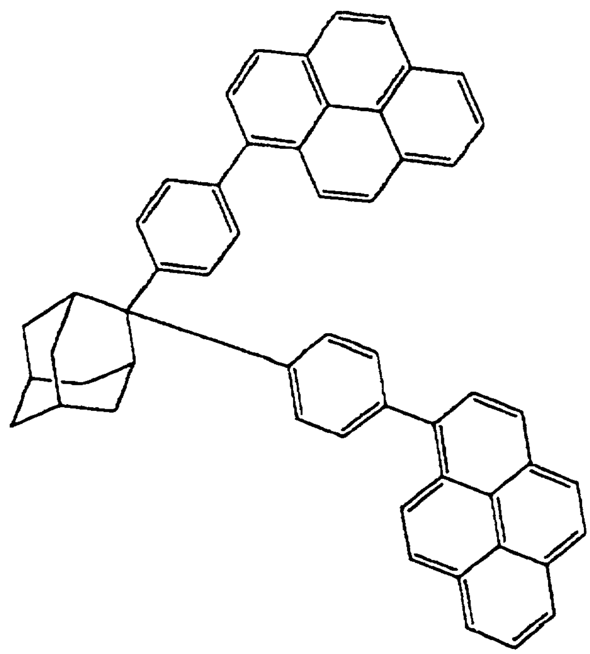
(20)

[Example 15]

300 mg of diiodophenyladamantane (compound 20), 510 mg of pyrenyl borate, 20 mg of $Pd(PPh_3)_4$, 400 mg of triethylamine, and 3 g of DMF were mixed, degassed, and then stirred and heated for 5 hours at 100 ℃. After DMF was removed, the mixture was separated with water-chloroform, dried with sodium sulfate, and evaporated.

The mixture was purified by column chromatography (silica-chloroform:hexane = 1:2) to obtain 150 mg of dipyrenyladamantane (compound 21).

An organic electro luminescent element using the compound 21 was prepared in the following steps. An ITO electrode was formed on a glass substrate and 60 nm of NPD (N,N'-dinaphthyl-N,N'-phenylbenzidine) was vacuum evaporated on the ITO layer as a hole transporting layer. 40 nm of compound 21 was evaporated on this layer as a luminescence layer and 20 nm of Alq3 (compound 2) was evaporated as an electron transporting layer. Finally, a Mg/Ag electrode (9:1) was evaporated to produce an organic electro luminescent element. The element was driven in a nitrogen gas atmosphere at room temperature. When an electric current of 10 mA/cm^2 was injected, a blue luminescence with a luminance of 250 cd/m^2 was obtained, and the half life of the luminance was 1000 hours.



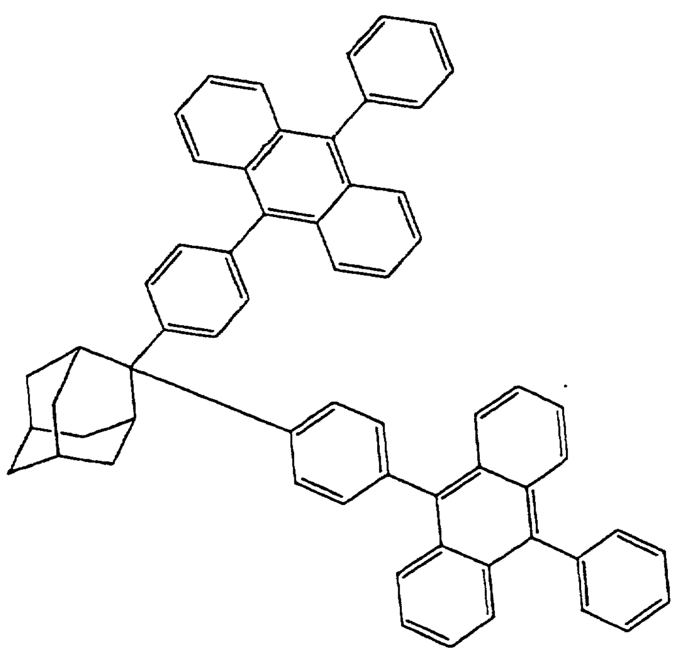
(21)

[Example 16]

250 mg of diiodophenyladamantane (compound 20), 510 mg of 10-(9-phenylanthryl) borate, 20 mg of $Pd(PPh_3)_4$, 350 mg of triethylamine, and 2.5 g of DMF were mixed, degassed, and then stirred and heated for 15 hours at 100 ℃. After DMF was removed, the mixture was separated with water-chloroform, dried with sodium sulfate, and evaporated. The mixture was purified by column chromatography (silica-chloroform:hexane = 1:3) to obtain 100 mg of di(9-phenylanthryl)adamantane (compound 22).

An organic electro luminescent element using the compound 22

was prepared in the following steps. An ITO electrode was formed on a glass substrate and 60 nm of NPD was vacuum evaporated on the ITO layer as a hole transporting layer. 40 nm of compound 22 was evaporated on this layer as a luminescence layer and 20 nm of Alq3 (compound 2) was evaporated as an electron transporting layer. Finally, a Mg/Ag electrode (9:1) was evaporated to produce an organic electro luminescent element. The element was driven in a nitrogen gas atmosphere at room temperature. When an electric current of 10 mA/cm^2 was injected, a blue luminescence with a luminance of 180 cd/m^2 was obtained, and the half life of the luminance was 1700 hours.

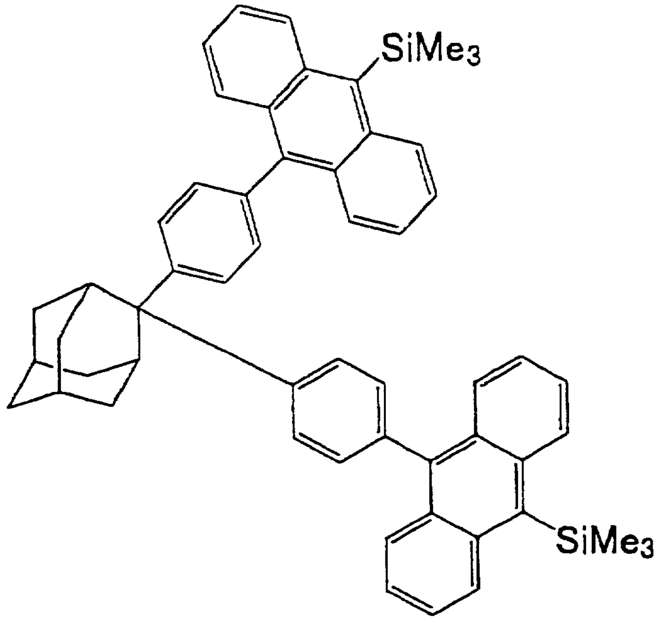


(22)

[Example 17]

100 mg of diiodophenyladamantane (compound 20), 650 mg of 10-(9-trimethylsilylanthryl) borate, 20 mg of $Pd(PPh_3)_4$, 250 mg of triethylamine, and 3 g of DMF were mixed, degassed, and then stirred and heated for 20 hours at 100 ℃. After DMF was removed, the mixture was separated with water-chloroform, dried with sodium sulfate, and evaporated. The mixture was purified by column chromatography (silica-chloroform:hexane = 1:5) to obtain 75 mg of di(9-trimethylsilylanthryl)adamantane (compound 23).

An organic electro luminescent element using compound 23 was prepared in the following steps. An ITO electrode was formed on a glass substrate and 60 nm of NPD was vacuum evaporated on the ITO layer as a hole transporting layer. 40 nm of compound 23 was evaporated on this layer as a luminescence layer and 20 nm of Alq3 (compound 2) was evaporated as an electron transporting layer. Finally, a Mg/Ag electrode (9:1) was evaporated to produce an organic electro luminescent element. The element was driven in a nitrogen gas atmosphere at room temperature. When an electric current of 10 mA/cm^2 was injected, a blue luminescence with a luminance of 220 cd/m^2 was obtained, and the half life of the luminance was 800 hours.



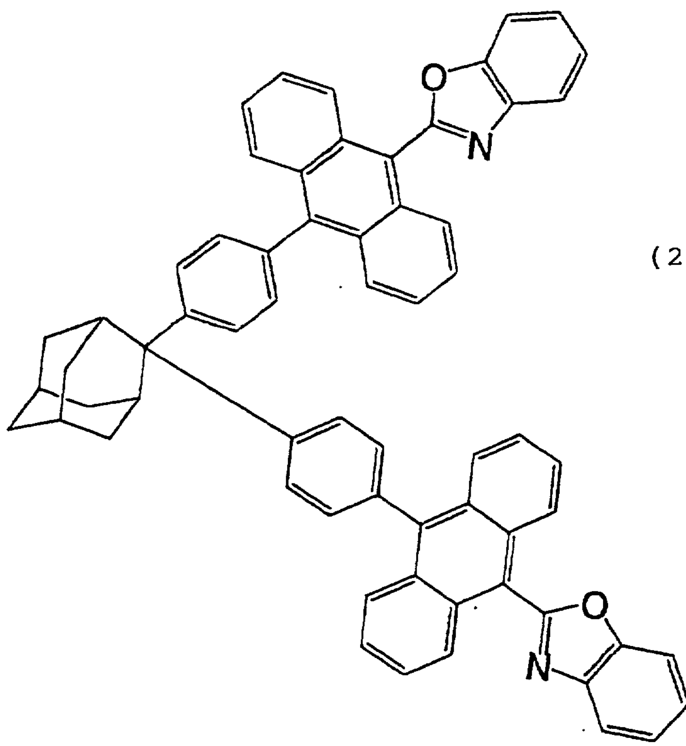
(23)

[Example 18]

150 mg of diiodophenyladamantane (compound 20), 700 mg of 10-(9-benzoxazolylanthryl) borate, 20 mg of $Pd(PPh_3)_4$, 350 mg of triethylamine, and 3 g of DMF were mixed, degassed, and then stirred and heated for 15 hours at 100℃. After DMF was removed, the mixture was separated with water-chloroform, dried with sodium sulfate, and evaporated. The mixture was purified by column chromatography (silica-chloroform:hexane = 1:3) to obtain 85 mg of di(9-benzoxazolylanthryl) adamantane (compound 24).

An organic electro luminescent element using compound 24 was prepared in the following steps. An ITO electrode was formed on a glass substrate and 60 nm of NPD was vacuum evaporated on the ITO layer as a hole transporting layer. 40 nm of compound 24 was evaporated on this layer as a luminescence layer and 20 nm of Alq3 (compound 2) was evaporated as an electron transporting layer. Finally, a Mg/Ag electrode (9:1) was evaporated to produce an

organic electro luminescent element. The element was driven in a nitrogen gas atmosphere at room temperature. When an electric current of 10 mA/cm^2 was injected, a blue luminescence with a luminance of 250 cd/m^2 was obtained, and the half life of the luminance was 1200 hours.



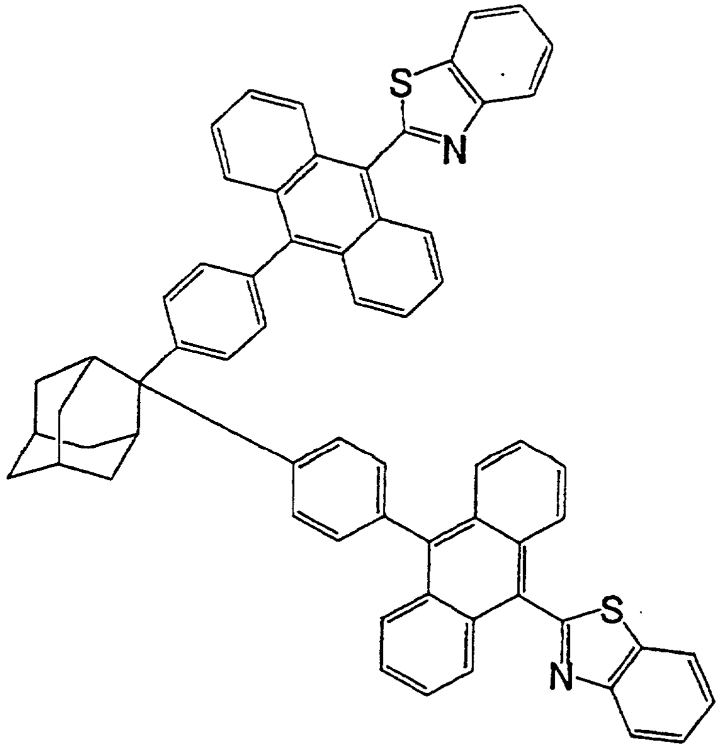
(24)

[Example 19]

150 mg of diiodophenyladamantane (compound 20), 700 mg of 10-(9-benzothiazolylanthryl) borate, 20 mg of $Pd(PPh_3)_4$, 350 mg of triethylamine, and 3 g of DMF were mixed, degassed, and then stirred and heated for 24 hours at 100℃. After DMF was removed, the mixture was separated with water-chloroform, dried with sodium sulfate,

and evaporated. The mixture was purified by column chromatography (silica-chloroform:hexane = 1:3) to obtain 85 mg of di(9-benzothiazolylanthryl)adamantane (compound 25).

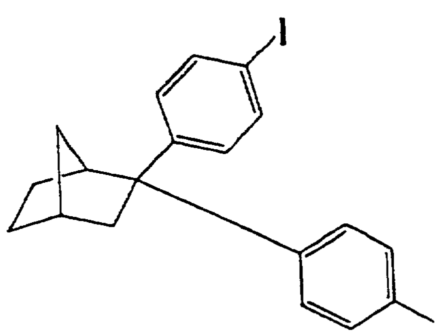
An organic electro luminescent element using compound 25 was prepared in the following steps. An ITO electrode was formed on a glass substrate and 60 nm of NPD was vacuum evaporated on the ITO layer as a hole transporting layer. 40 nm of compound 25 was evaporated on this layer as a luminescence layer and 20 nm of Alq3 (compound 2) was evaporated as an electron transporting layer. Finally, a Mg/Ag electrode (9:1) was evaporated to produce an organic electro luminescent element. The element was driven in a nitrogen gas atmosphere at room temperature. When an electric current of 10 mA/cm^2 was injected, a blue luminescence with a luminance of 180 cd/m^2 was obtained, and the half life of the luminance was 2000 hours.



(25)

[Example 20]

Dianilinonorbornane was synthesized from norbornanone in a similar manner to the synthesis of dianilinoadamantane (compound 14) and diiodophenylnorbornane (compound 26) was synthesized from dianilinonorbornane in a similar manner to the Example 14.

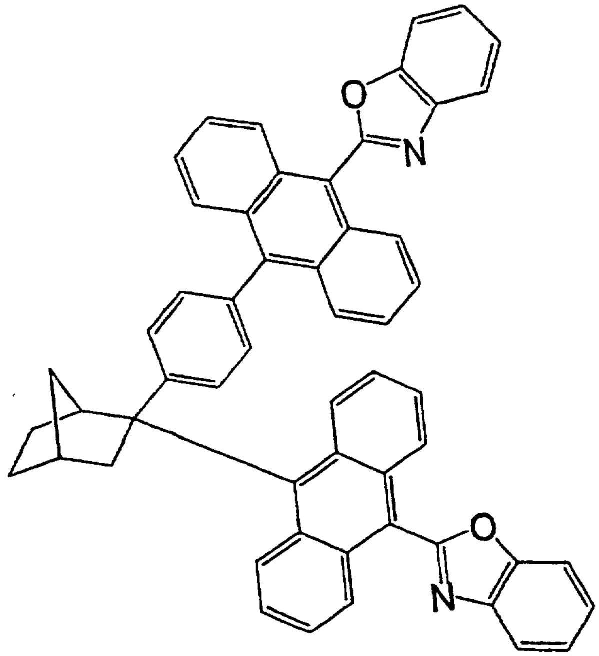


(26)

[Example 21]

200 mg of diiodophenylnorbornane (compound 26), 800 mg of 10-(9-benzothiazolylanthryl) borate, 20 mg of $Pd(PPh_3)_4$, 400 mg of triethylamine, and 3 g of DMF were mixed, degassed, and then stirred and heated for 32 hours at 100℃. After DMF was removed, the mixture was separated with water-chloroform, dried with sodium sulfate, and evaporated. The mixture was purified by column chromatography (silica-chloroform:hexane = 1:5) to obtain 120 mg of di(9-benzothiazolylanthryl) norbornane (compound 27).

An organic electro luminescent element using compound 27 was prepared in the following steps. An ITO electrode was formed on a glass substrate and 60 nm of NPD was vacuum evaporated on the ITO layer as a hole transporting layer. 40 nm of compound 27 was evaporated on this layer as a luminescence layer and 20 nm of Alq3 (compound 2) was evaporated as an electron transporting layer. Finally, a Mg/Ag electrode (9:1) was evaporated to produce an organic electro luminescent element. The element was driven in a nitrogen gas atmosphere at room temperature. When an electric current of 10 mA/cm^2 was injected, a blue luminescence with a luminance of 250 cd/m^2 was obtained, and the half life of the luminance was 1200 hours.



(27) ,

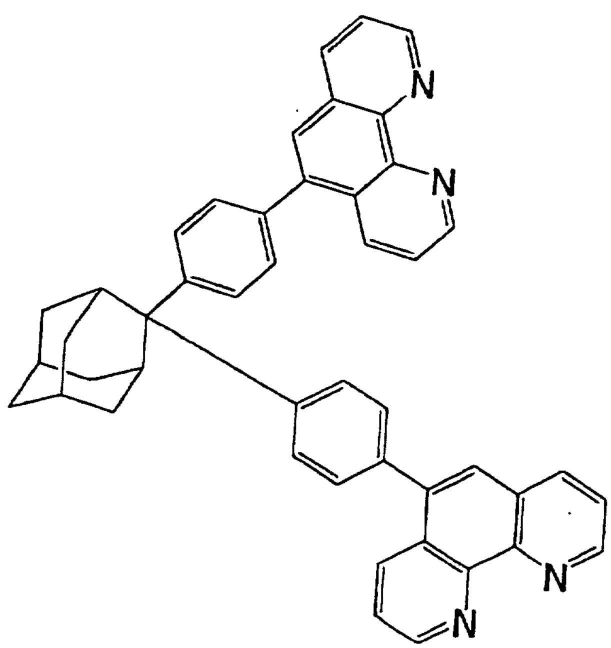
[Example 22]

150 mg of diiodophenyladamantane (compound 20), 800 mg of 5-phenanthryl borate, 20 mg of $Pd(PPh_3)_4$, 340 mg of triethylamine, and 3 g of DMF were mixed, degassed, and then stirred and heated for 25 hours at 100 ℃. After DMF was removed, the mixture was separated with water-chloroform, dried with sodium sulfate, and evaporated. The mixture was purified by column chromatography (silica-chloroform:hexane = 1:3) to obtain 85 mg of diphenanthryladamantane (compound 28).

An organic electro luminescent element using compound 28 was prepared in the following steps. An ITO electrode was formed on a glass substrate and 60 nm of NPD was vacuum evaporated on the

ITO layer as a hole transporting layer. 40 nm of compound 24 was evaporated on this layer as a luminescence layer and 20 nm of compound 28 was evaporated as an electron transporting layer. Finally, a Mg/Ag electrode (9:1) was evaporated to produce an organic electro luminescent element. The element was driven in a nitrogen gas atmosphere at room temperature. When an electric current of 10 mA/cm^2 was injected, a blue luminescence with a luminance of 330 cd/m^2 was obtained, and the half life of the luminance was 1800 hours.

As described, according to the present invention, by using a condensed ring compound derivative or an adamantane derivative as the hole transporting, luminescence, and electron transporting molecule, low crystallinity and high heat endurance, which are preferable characteristics as a material for an organic electro luminescent element, can be imparted to the element while maintaining superior electric characteristics.

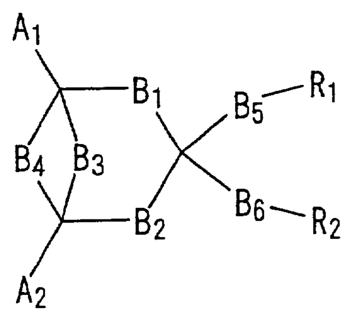


(28)

What is claimed is:

1. An electro luminescent element comprising at least one organic compound layer between electrodes, wherein,

at least one said organic compound layer is a condensed ring compound derivative represented by the chemical formula,



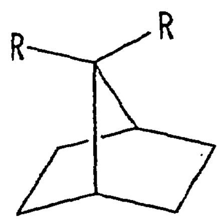
in which A1 and A2 represent substituents, B1 through B6 represent directly combined or 2-functional substituents, and R1 and R2 represent functional units with hole transporting ability, luminescence, and electron transporting ability.

2. An electro luminescent element according to claim 1, wherein each of said functional units R1 and R2 is selected from the group consisting of triphenylamine, coumarin, and oxadiazole derivative.

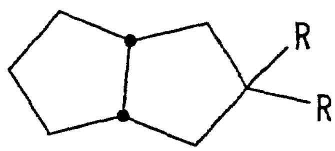
3. An electro luminescent element according to claim 1, wherein said condensed ring compound derivative is distributed among host materials and the host materials are further layered

in said organic compound layer.

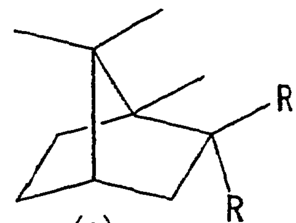
4. An electro luminescent element according to claim 1, wherein said condensed ring compound derivative has a structure represented by one of the following chemical formulae, (a) to (l):



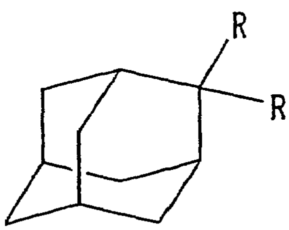
(a)



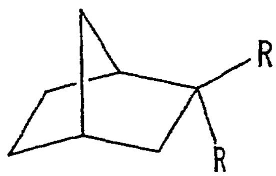
(b)



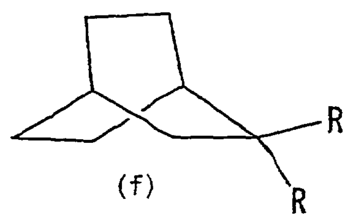
(c)



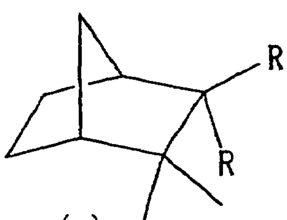
(d)



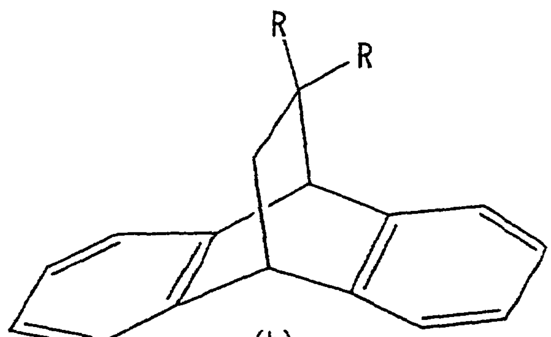
(e)



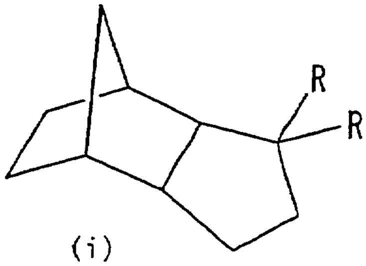
(f)



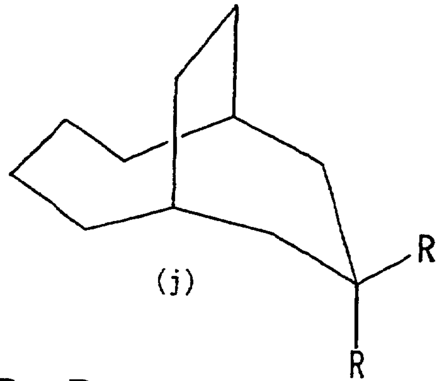
(g)



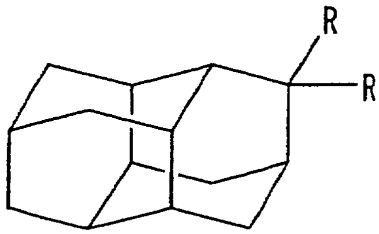
(h)



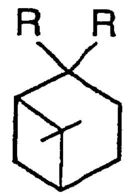
(i)



(j)



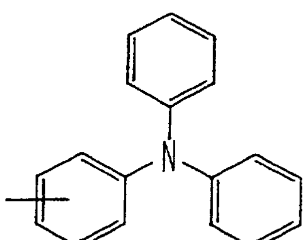
(k)



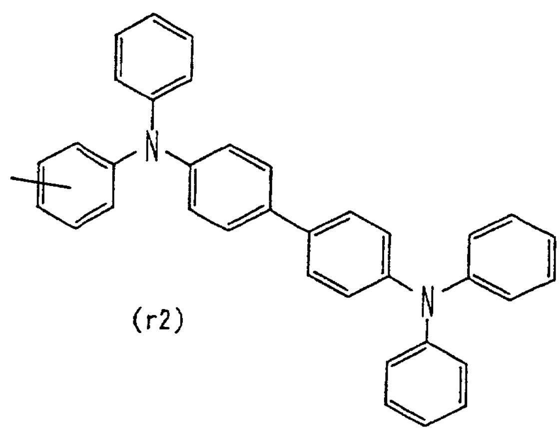
(l)

in which R represents said functional unit.

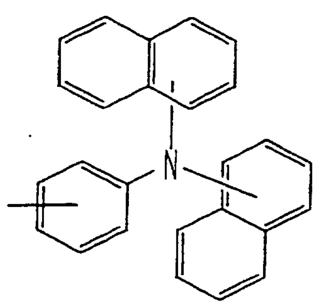
5. An electro luminescent element according to claim 1, wherein, said functional unit has a structure represented by one of the following chemical formulae, (r1) to (r22):



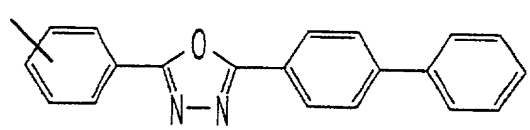
(r1)



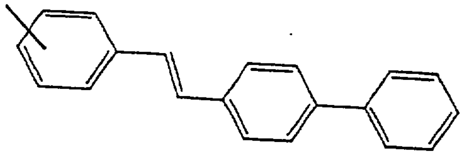
(r2)



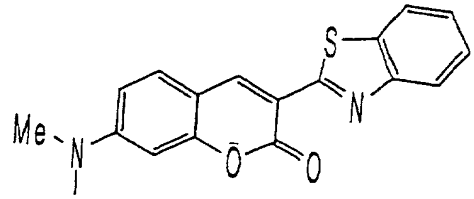
(r3)



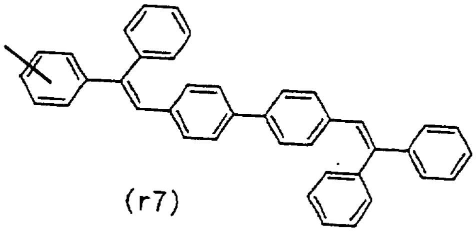
(r4)



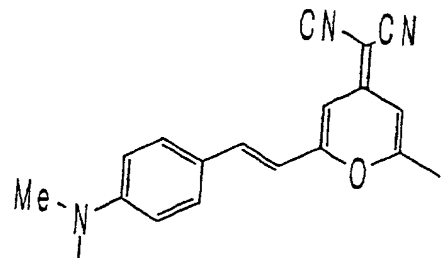
(r5)



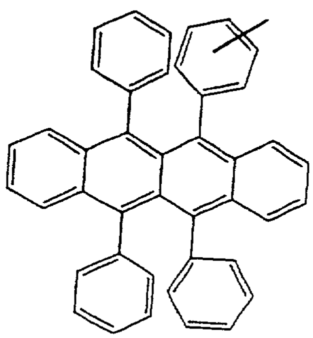
(r6)



(r7)

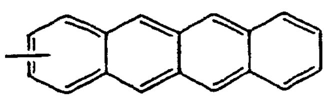


(r8)

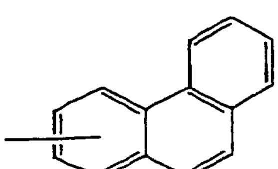


(r9)

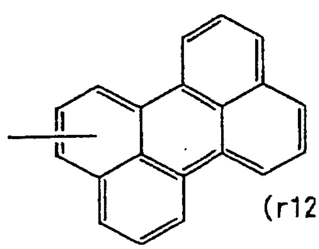
and



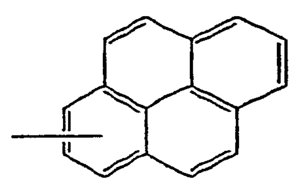
(r10)



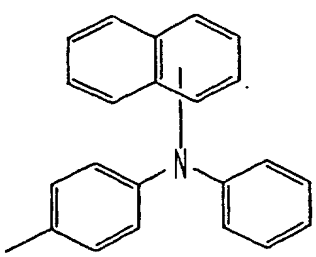
(r11)



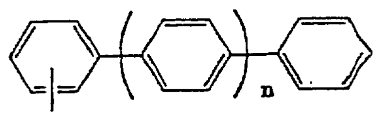
(r12)



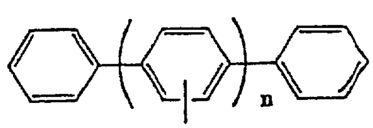
(r13)



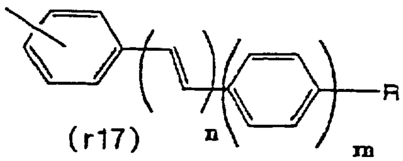
(r14)



(r15)



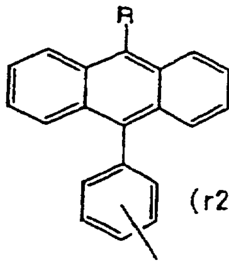
(r16)



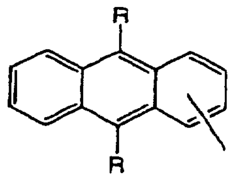
(r17)

$-R_1-R_2\cdots R_{n-1}-R_n$ (r18)

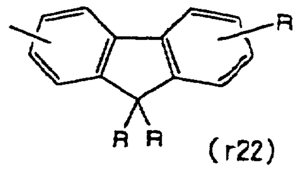
(r19)



(r20)



(r21)



(r22)

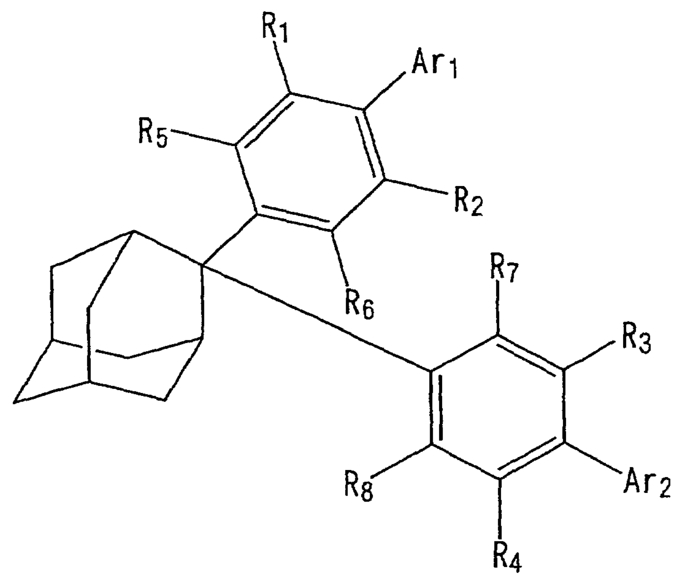
in which n, m, and i represent integers, R represents saturated hydrocarbon from C1 through C30, an isomer thereof, or an aromatic compound.

6. An electro luminescent element according to claim 5, whrein said aromatic compound R is selected from the group consisting of phenyl, naphthyl, indenyl, fluorenyl, phenanthryl, anthranyl, pyrenyl, chrysenyl, naphthacenyl, benzophenanthrenyl, furanyl, thiophenyl, pyrrolyl, oxazolyl, isoxazolyl, pyrazolyl, triazolyl, furazalyl, pyridyl, oxazyl, morpholyl, thiazyl, pyridazyl, pyrimidyl, pyrazyl, triazyl, benzofuryl, isobenzofuryl, benzothiophenyl, indolyl, isoindolyl, benzoxazolyl, benzothiazolyl, benzoimidazolyl, chromelyl, quinolyl, isoquinolyl, cinnolyl, phthalazyl, quinazolyl, quinoxalyl, dibenzofuril, carbazolyl, xanthenyl, acridinyl, phenanthridinyl, phenanthryl, phenazinyl, phenoxazinyl, thianthrenyl, indolizinyl, quinolizinyl,

naphthyridinyl, purinyl, puritedinyl, oxadiazolyl, oxathiazolyl, >C=C<, >C=N-, -N=N-, -N(R)-, -O-, -S-, -SO-, $-SO_2-$, -Si(R2)-, >C=Si<, -C≡C-, and -B(R)-.

7. An electro luminescent element comprising at least one organic compound layer between electrodes, wherein,

at least one said organic compound layer is an adamantane derivative represented by the chemical formula,



in which R1 through R8 represent substituents, and Ar1 and Ar2 represent functional units having hole transporting ability, luminescence, and electron transporting ability.

8. An electro luminescent element according to claim 7, wherein,

said adamantane derivative is distributed among host materials and the host materials are further layered in said organic compound layer.

9. An electro luminescent element according to claim 7, wherein each of said substituents R1 through R8 is a functional group selected from a group of alkyl group, aryl group, allyl group, alkene group, alkyne group, alkoxy group, hydroxyl group, hydroxylate group, thiocarboxy group, dithiocarboxy group, sulfo group, sulfino group, sulfeno group, oxycarbonyl group, haloformyl group, carbamoyl group, hydrazinocarbonyl group, amidino group, cyano group, isocyano group, cyanato group, isocyanato group, thiocyanato group, isothiocyanato group, formyl group, oxo group, thioformyl group, thioxo group, mercapto group, amino group, imino group, hydrazino group, aryloxy group, sulfide group, halogen group, nitro group, and silyl group.

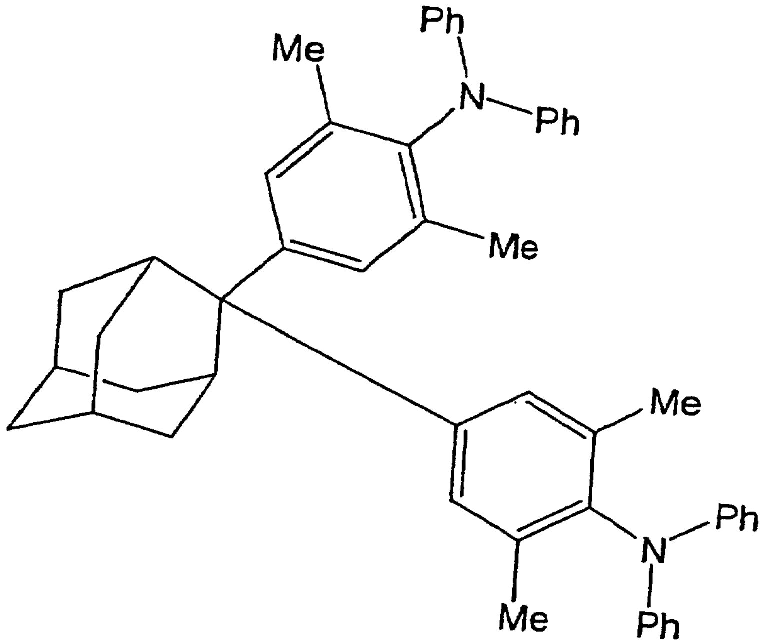
10. An electro luminescent element according to claim 7, wherein each of said functional units Ar1 and Ar2 has an aryl skeleton as a basic skeleton.

11. An electro luminescent element according to claim 10, wherein said aryl skeleton is selected from the group of consisting

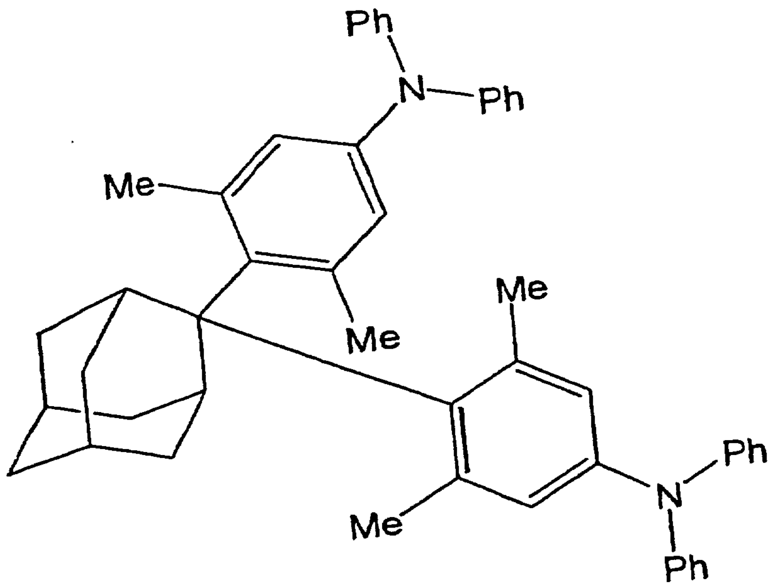
of phenyl, naphthyl, and phenanthryl.

12. An electro luminescent element according to claim 10, wherein each of said functional units Ar1 and Ar2 is further substituted by a functional group selected from a group of alkyl group, aryl group, allyl group, alkene group, alkyne group, alkoxy group, hydroxyl group, hydroxylate group, thiocarboxy group, dithiocarboxy group, sulfo group, sulfino group, sulfeno group, oxycarbonyl group, haloformyl group, carbamoyl group, hydrazinocarbonyl group, amidino group, cyano group, isocyano group, cyanato group, isocyanato group, thiocyanato group, isothiocyanato group, formyl group, oxo group, thioformyl group, thioxo group, mercapto group, amino group, imino group, hydrazino group, alkoxy group, aryloxy group, sulfide group, halogen group, nitro group, and silyl group.

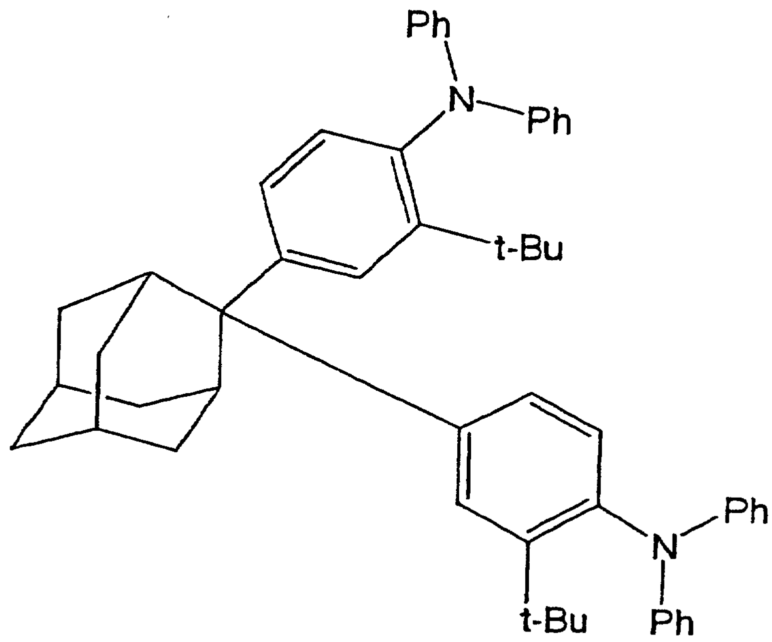
13. An electro luminescent element according to claim 7, wherein said adamantane derivative has a structure represented by one of the following chemical formulae (a1) to (a13):



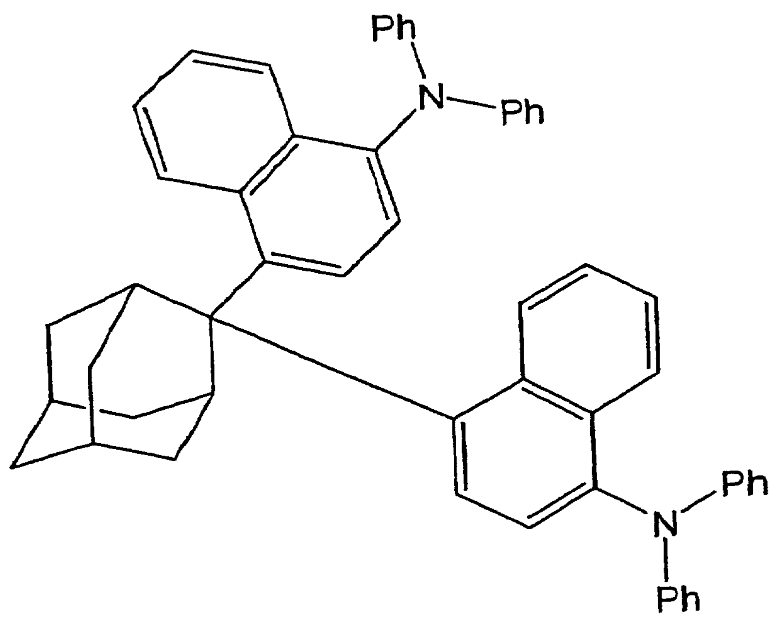
(a1)



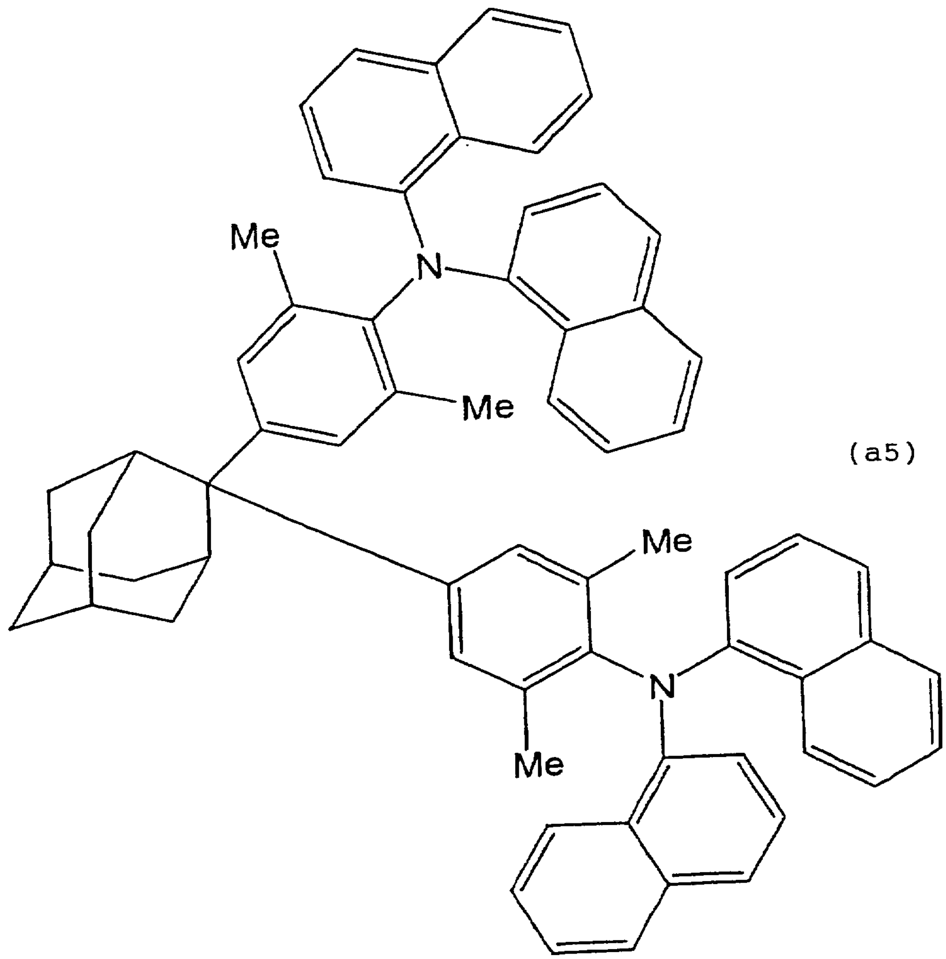
(a2)



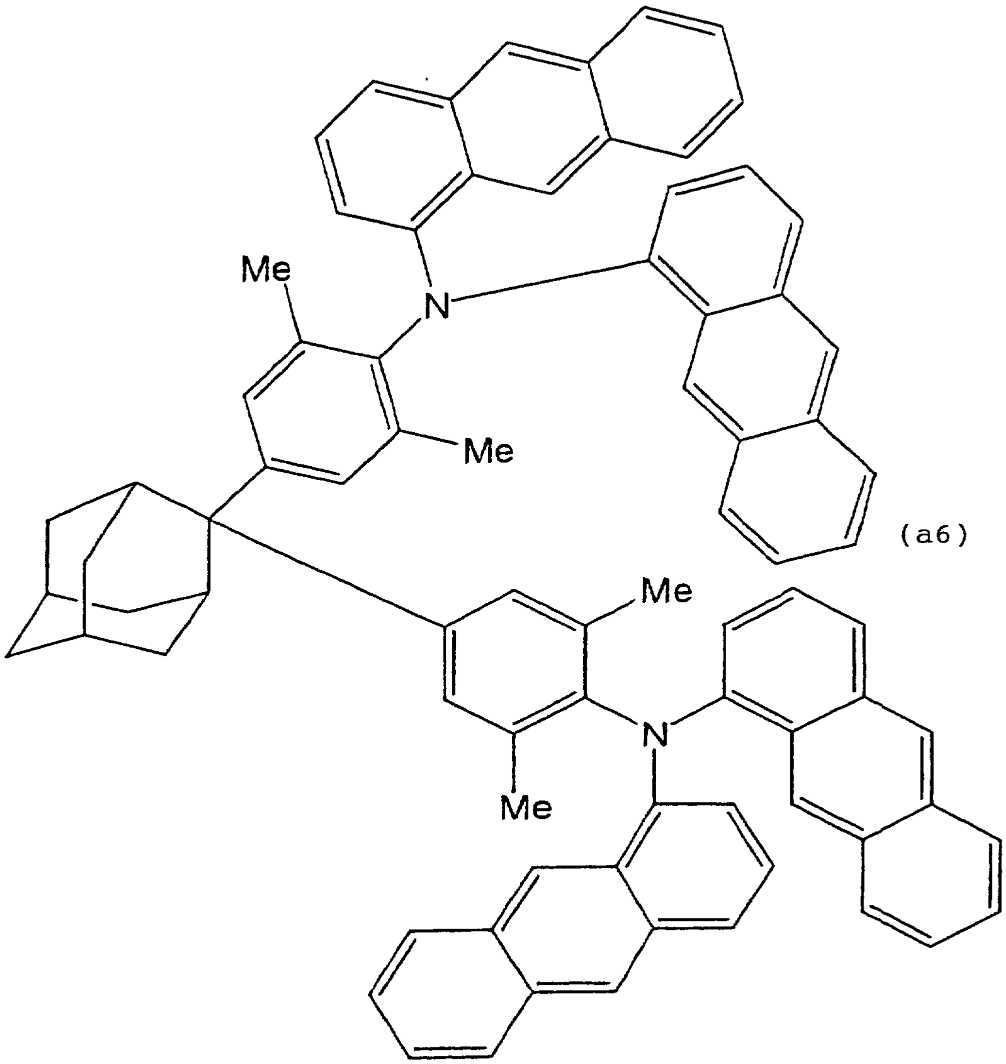
(a3)



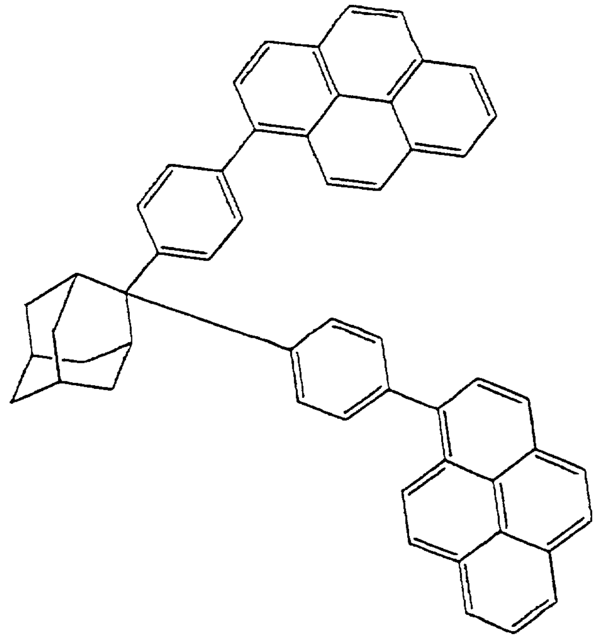
(a4)



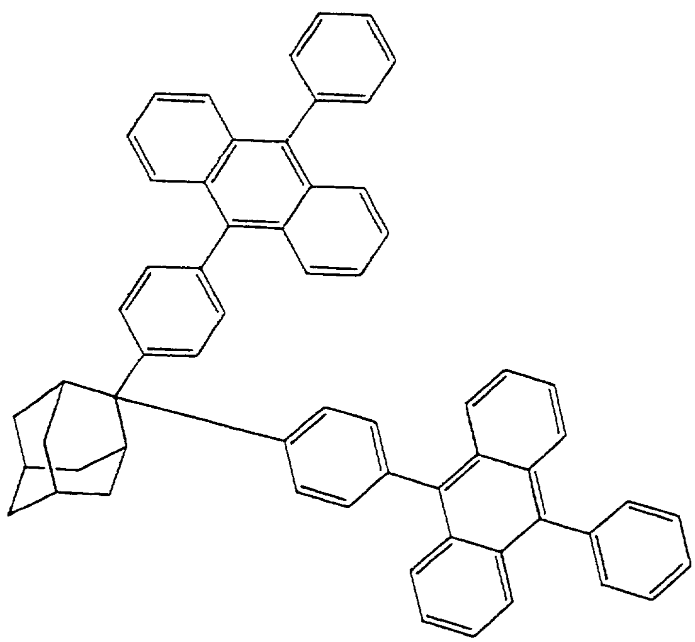
(a5)



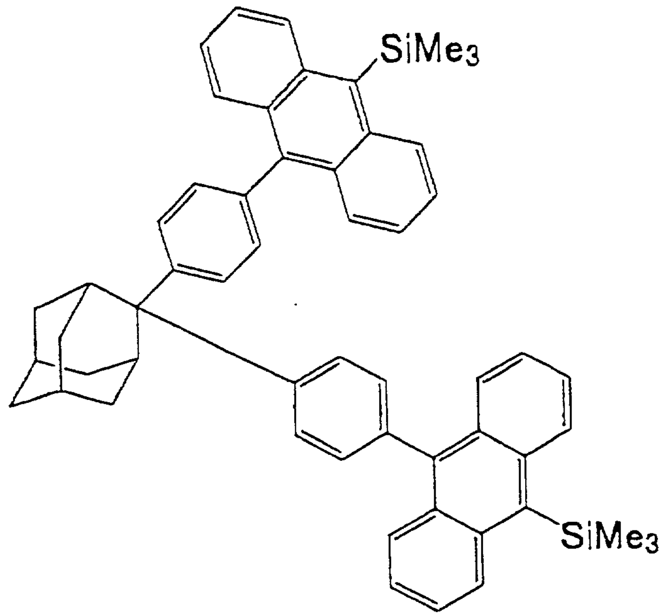
(a6)



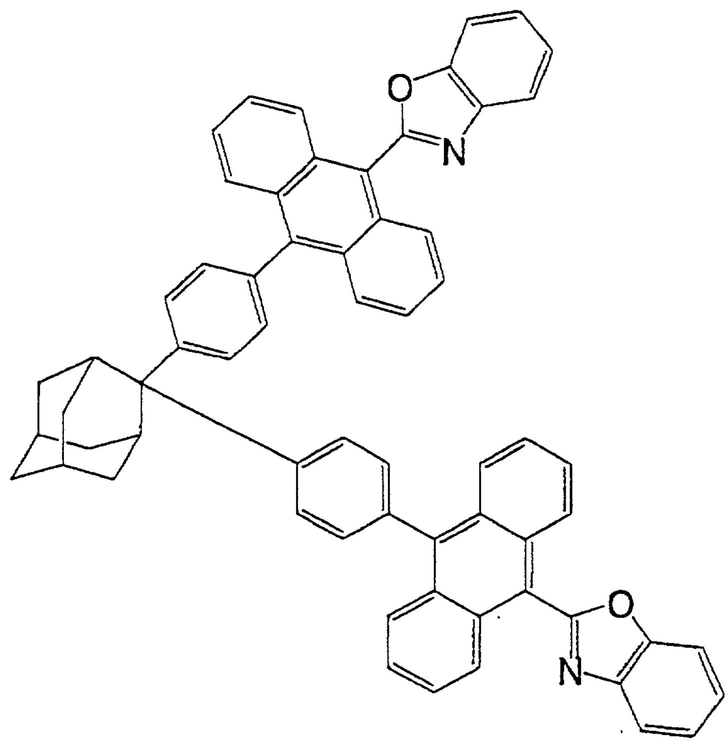
(a7)



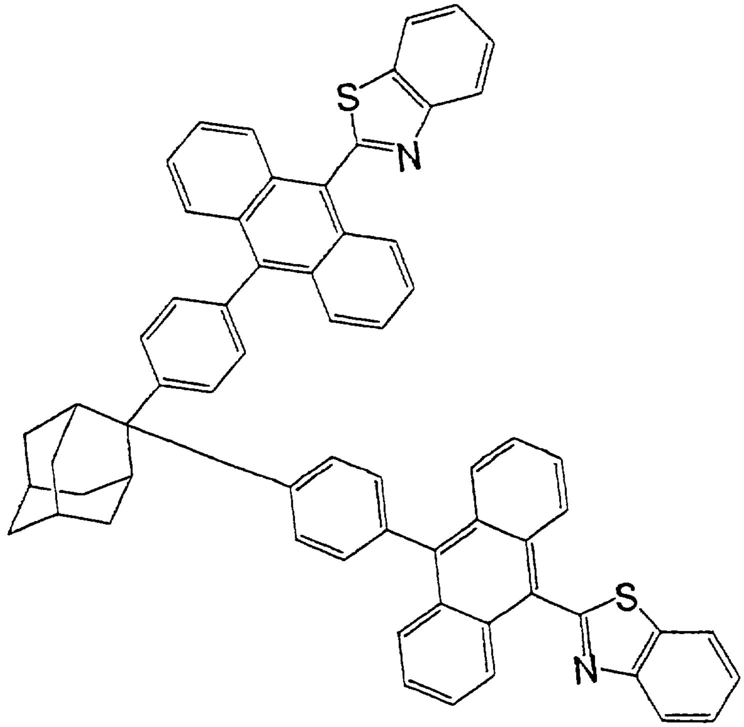
(a8)



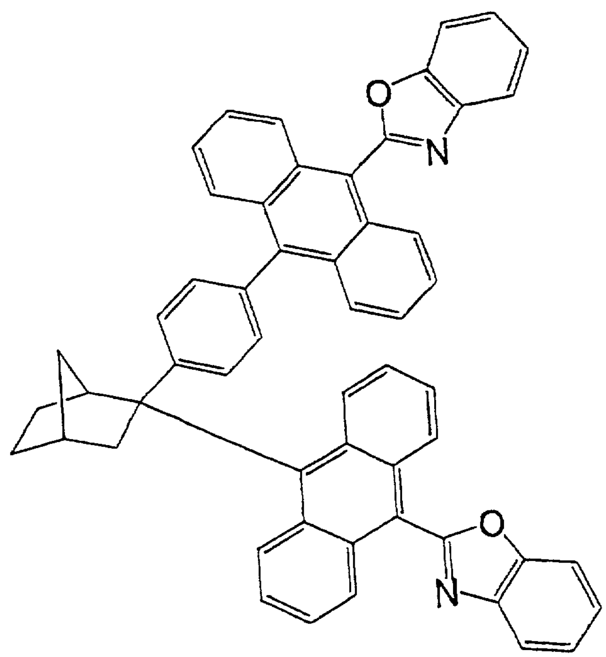
(a9)



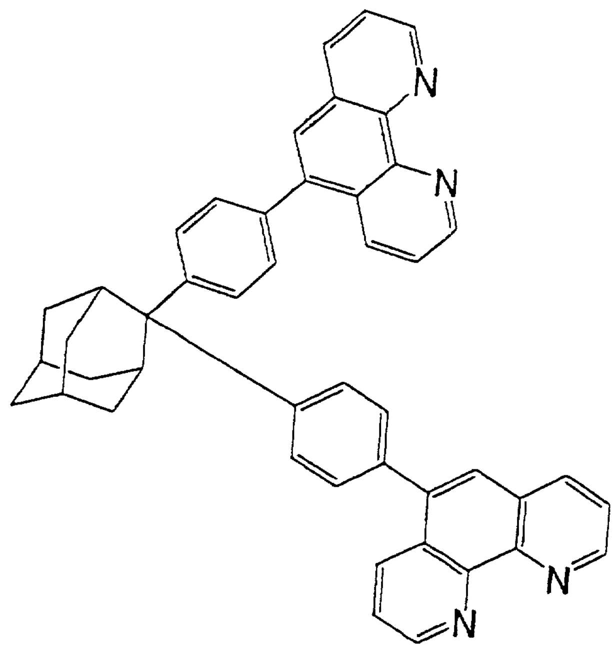
(a10)



(a11)



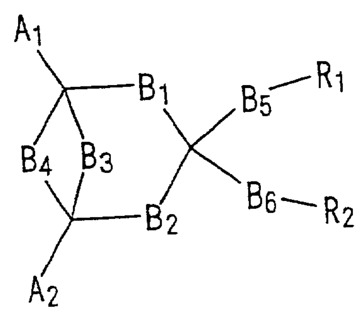
(a12)



(a13)

ABSTRACT OF THE DISCLOSURE

In order to provide an electro luminescent element with high heat endurance and low crystallinity using functional molecules having functions of hole transporting, luminescence, and electron transporting, an electro luminescent element according to the present invention comprises one or more organic compound layers 14 between a first electrode 12 and a second electrode 16, wherein at least one of the organic compound layers 14 is a condensed ring compound derivative represented by the following chemical formula,



in which A1 and A2 represent substituents, B1 through B6 represent directly connected or di functional substituents, and R1 and R2 represent functional units having each of the functions of hole transporting, luminescence, and electron transporting, such as triphenylamine, coumarin, and oxadiazole derivative.

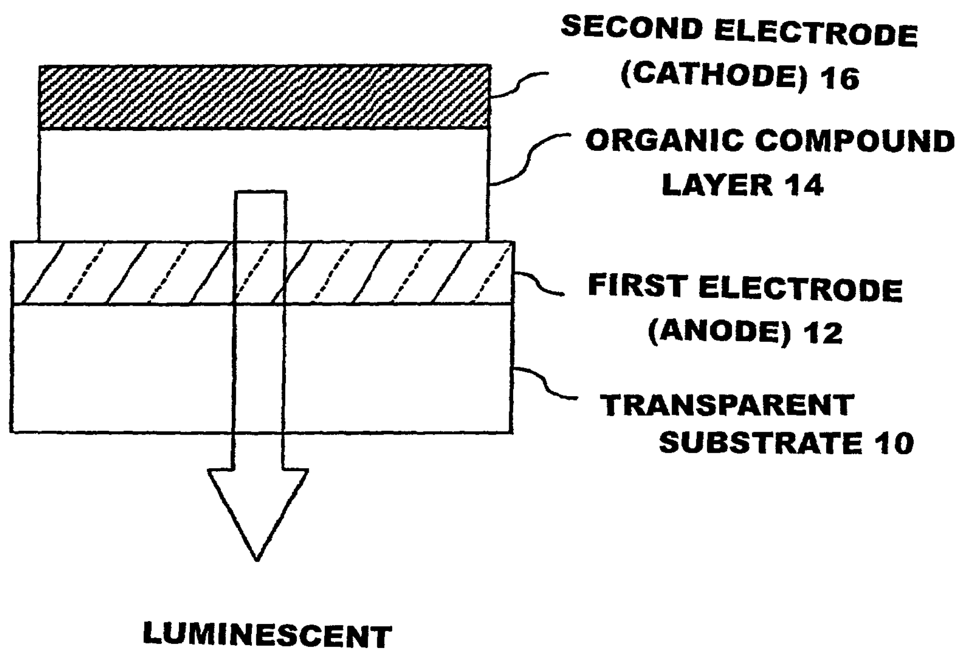

SECOND ELECTRODE
(CATHODE) 16
ORGANIC COMPOUND
LAYER 14
FIRST ELECTRODE
(ANODE) 12
TRANSPARENT
SUBSTRATE 10
LUMINESCENT

Fig. 1

Declaration and Power of Attorney For Patent Application

特許出願宣言書及び委任状

Japanese Language Declaration

日本語宣言書

下記の氏名の発明者として、私は以下の通り宣言します。

As a below named inventor, I hereby declare that:

私の住所、私書箱、国籍は下記の私の氏名の後に記載された通りです。

My residence, post office address and citizenship are as stated next to my name.

下記の名称の発明に関して請求範囲に記載され、特許出願している発明内容について、私が最初かつ唯一の発明者（下記の氏名が一つの場合）もしくは最初かつ共同発明者（下記の名称が複数の場合）であると信じています。

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled.

ELECTRO LUMINESCENT ELEMENT

上記発明の明細書は、

☐ 本書に添付されています。

☐ ＿月＿日に提出され、米国出願番号または特許協定条約国際出願番号を＿＿＿＿とし、(該当する場合) ＿＿＿＿に訂正されました。

the specification of which

☒ is attached hereto.

☐ was filed on ＿＿＿＿ as United States Application Number or PCT International Application Number ＿＿＿＿ and was amended on ＿＿＿＿ (if applicable).

私は、特許請求範囲を含む上記訂正後の明細書を検討し、内容を理解していることをここに表明します。

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

私は、連邦規則法典第37編第1条56項に定義されるとおり、特許資格の有無について重要な情報を開示する義務があることを認めます。

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

Japanese Language Declaration
（日本語宣言書）

私は、米国法典第35編119条（a）-（d）項又は365条（b）項に基づき下記の、米国以外の国の少なくとも一ヵ国を指定している特許協力条約365（a）項に基づく国際出願、又は外国での特許出願もしくは発明者証の出願についての外国優先権をここに主張するとともに、優先権を主張している、本出願の前に出願された特許または発明者証の外国出願を以下に、枠内をマークすることで、示しています。

I hereby claim foreign priority under Title 35, United States Code, Section 119 (a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or Section 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)
外国での先行出願

(Number)（番号）	(Country)（国名）	(Day/Month/Year Filed)（出願年月日）	Priority Claimed 優先権主張 Yes はい	No いいえ
Hei 11-221653	Japan	04/08/1999	☒	☐
			☐	☐

私は、第35編米国法典119条（e）項に基づいて下記の米国特許出願規定に記載された権利をここに主張いたします。

I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below.

(Application No.)（出願番号）	(Filing Date)（出願日）

私は、下記の米国法典第35編120条に基づいて下記の米国特許出願に記載された権利、又は米国を指定している特許協力条約365条（c）に基づく権利をここに主張します。また、本出願の各請求範囲の内容が米国法典第35編112条第1項又は特許協力条約で規定された方法で先行する米国特許出願に開示されていない限り、その先行米国出願書提出日以降で本出願書の日本国内または特許協力条約国際提出日までの期間中に入手された、連邦規則法典第37編1条56項で定義された特許資格の有無に関する重要な情報について開示義務があることを認識しています。

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s), or Section 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code Section 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of application.

(Application No.)（出願番号）	(Filing Date)（出願日）	(Status: Patented, Pending, Abandoned)（現況：特許許可済、係属中、放棄済）

私は、私自信の知識に基づいて本宣言書中で私が行なう表明が真実であり、かつ私の入手した情報と私の信じるところに基づく表明が全て真実であると信じていること、さらに故意になされた虚偽の表明及びそれと同等の行為は米国法典第18編第1001条に基づき、罰金または拘禁、もしくはその両方により処罰されること、そしてそのような故意による虚偽の声明を行なえば、出願した、又は既に許可された特許の有効性が失われることを認識し、よってここに上記のごとく宣誓を致します。

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Japanese Language Declaration

(日本語宣言書)

委任状：私は下記の発明者として、本出願に関する一切の手続きを米特許商標局に対して遂行する弁理士または代理人として、下記の者を指名いたします。
(弁護士、または代理人の指名及び登録番号を明記のこと)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: *(list name and registration number)*

Norman F. Oblon, Reg. No. 24,618; Marvin J. Spivak, Reg. No. 24,913; C. Irvin McClelland, Reg. No. 21,124; Gregory J. Maier, Reg. No. 25,599; Arthur I. Neustadt, Reg. No. 24,854; Richard D. Kelly, Reg. No. 27,757; James D. Hamilton, Reg. No. 28,421; Eckhard H. Kuesters, Reg. No. 28,870; Robert T. Pous, Reg. No. 29,099; Charles L. Gholz, Reg. No. 26,395; William E. Beaumont, Reg. No. 30,996; Robert F. Gnuse, Reg. No. 27,295; Jean-Paul Lavalleye, Reg. No. 31,451; Stephen G. Baxter, Reg. No. 32,884; Robert W. Hahl, Reg. No. 33,893; Richard L. Treanor, Reg. No. 36,379; Steven P. Weihrouch, Reg. No. 32,829; John T. Goolkasian, Reg. No. 26, 142; Richard L. Chinn, Reg. No. 34,305; Steven E. Lipman, Reg. No. 30,011; Carl E. Schlier, Reg. No. 34,426; James J. Kulbaski, Reg. No. 34,648; Richard A. Neifeld, Reg. No. 35,299; J. Derek Mason, Reg. No. 35,270; Surinder Sachar, Reg. No. 34,423; Christina M. Gadiano, Reg. No. 37,628; Jeffrey B. McIntyre, Reg. No. 36,867; Paul E. Rauch, Reg. No. 38,591; William T. Enos, Reg. No. 33,128 and Michael E. McCabe, Jr., Reg. No. 37,182, with full powers of substitution and revocation.

書類送付先

Send Correspondence to:

OBLON, SPIVAK, McCLELLAND, MAIER & NEUSTADT, P.C.
FOURTH FLOOR
1755 JEFFERSON DAVIS HIGHWAY
ARLINGTON, VIRGINIA 22202 U.S.A.

直接電話連絡先：（名前及び電話番号）

Direct Telephone Calls to: (name and telephone number)
(703) 413-3000

単独発明者または第一の共同発明者の氏名	Full name of sole or first joint inventor Hiromitsu TANAKA
発明者の署名 日付	Inventor's signature Date Hiromitsu Tanaka July 21, 2000
住所	Residence Aichi-ken, Japan
国籍	Citizenship Japan
郵便の宛先	Post Office Address c/o KABUSHIKI KAISHA TOYOTA CHUO KENKYUSHO
	41-1, Aza Yokomichi, Oaza Nagakute, Nagakute-cho, Aichi-gun, Aichi-ken, 480-1192 Japan
第二の共同発明者の氏名	Full name of second joint inventor, if any Makoto MOURI
第二の共同発明者の署名 日付	Second joint Inventor's signature Date Makoto Mori July 21, 2000
住所	Residence Aichi-ken, Japan
国籍	Citizenship Japan
郵便の宛先	Post Office Address c/o KABUSHIKI KAISHA TOYOTA CHUO KENKYUSHO
	41-1, Aza Yokomichi, Oaza Nagakute, Nagakute-cho, Aichi-gun, Aichi-ken, 480-1192 Japan

(第三以降の共同発明者についても同様に記載し、署名すること)

(Supply similar information and signature for third and subsequent joint inventors.)

Japanese Language Declaration
(日本語宣言書)

第三の共同発明者の氏名	Full name of third joint inventor, if any Hisato TAKEUCHI
第三の共同発明者の署名　日付	Third joint Inventor's signature　Date Hisato Takeuchi　July 21, 2000
住所	Residence Aichi-ken, Japan
国籍	Citizenship Japan
郵便の宛先	Post Office Address c/o KABUSHIKI KAISHA TOYOTA CHUO KENKYUSHO
	41-1, Aza Yokomichi, Oaza Nagakute, Nagakute-cho, Aichi-gun, Aichi-ken, 480-1192 Japan

第四の共同発明者の氏名	Full name of fourth joint inventor, if any Shizuo TOKITO
第四の共同発明者の署名　日付	Fourth joint Inventor's signature　Date Shizuo Tokito　July 21, 2000
住所	Residence Aichi-ken, Japan
国籍	Citizenship Japan
郵便の宛先	Post Office Address c/o KABUSHIKI KAISHA TOYOTA CHUO KENKYUSHO
	41-1, Aza Yokomichi, Oaza Nagakute, Nagakute-cho, Aichi-gun, Aichi-ken, 480-1192 Japan

第五の共同発明者の氏名	Full name of fifth joint inventor, if any
第五の共同発明者の署名　日付	Fifth joint Inventor's signature　Date
住所	Residence
国籍	Citizenship
郵便の宛先	Post Office Address

第六の共同発明者の氏名	Full name of sixth joint inventor, if any
第六の共同発明者の署名　日付	Sixth joint Inventor's signature　Date
住所	Residence
国籍	Citizenship
郵便の宛先	Post Office Address